KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

LONDON: JUNE 1, 1897.

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AN INVISIBLE MONKEY.

By R. LYDEKKER, B.A.Cantab., F.R.S.

IN most English dictionaries the verb to "mimic" has for its synonyms "to ape, imitate, counterfeit, or mock"; and it is thus intimately connected with the monkey tribe, whose imitations of human gestures and actions form one of their most prominent characteristic features. Till quite recently, naturalists have, however, been totally unacquainted with any instance among these animals of "mimicry" in its scientific sense. That is to say, no case was known where a monkey, for the sake of protection, resembled in form or coloration either some other animal or an inanimate object. During his adventurous journey to Mount Kenya and Lake Barengo, in East Africa, Dr. J. W. Gregory, of the Natural History Museum, was fortunate enough to make the interesting discovery that the peculiar type of coloration characterizing certain African monkeys is protective in its nature, and that these monkeys, when in their native haunts, are thereby rendered practically invisible.

The monkeys in question (one of which is represented in the accompanying figure) are known to the natives of certain districts of East Africa by the name of "guereza." They belong to the group of thumbless apes (*Colobus*), which are restricted to the African continent, where they take the place of the langurs, or sacred apes, of India and other Oriental countries. From the other thumbless apes the guerezas (or those species to which that name properly applies) are distinguished by their long, silky, black and white coats, which are much sought after by the natives of Africa as articles of their scanty costume and for purposes of decoration. In the typical Abyssinian guereza the greater part of the fur of the body and limbs is of a deep shining black, but from the shoulders there depends a mantle of long, white, silky hairs, extending down each side and meeting on the lower part of the back, so as to hang down over the sides of the body as well as over the hips and thighs. The terminal third of the tail is also clothed with long white hairs. Strikingly handsome as is this species, it is excelled in this respect by the East African guereza —the one met with by Dr. Gregory—in which the base of the tail is alone black, the whole of the remainder of that appendage being developed into a magnificent white brush, which may be compared to an Indian *chowri*, or fly-whisk.

Black and white is a type of coloration so conspicuous, and, at the same time, so rare, among the larger mammals, that whenever it occurs we may be quite sure it is developed for some special purpose, although, unless we have an opportunity of seeing the animals in their native haunts, it is almost impossible to divine what that purpose may be. It is met with elsewhere in the zebras, and also in the remarkable parti-coloured bear (*Æluropus*) of Tibet. Although the former animals are conspicuous enough in a stall at the "Zoo," or when stuffed in a museum, travellers tell us that when seen in the haze of an African desert, their black and white stripes fade at a very short distance to an almost invisible grey. This may even be observed in a hot summer, when the grass is burnt brown, in the Duke of Bedford's seat at Woburn Abbey, where several of these beautiful animals are allowed to roam at will in the park during the summer months.

With regard to the parti-coloured bear, we have at present no information. It may be suggested, however, that the startling contrast presented by its streaks and patches of creamy white on a jet black ground, may harmonize with patches of snow on black rocks, or possibly with the lines of light between the dark stems of forest trees.

Be this as it may, Dr. Gregory's observations have fully solved the problem of the use of the remarkable coloration of the guerezas, which has so long puzzled the brains of naturalists. Like others of their kind, these monkeys pass most of their time high up on trees, where they sleep either resting on a bough or hanging beneath by their hands, or hands and feet. Now, in the dense forests clothing Mount Kilima Njaro, and other districts of East Africa, the black-stemmed trees are thickly draped with pendant masses and wreaths of grey beardmoss, or lichen, which reach for several feet below the boughs. "As the monkeys hang from the branches," writes Dr. Gregory, "they so closely resemble the lichen that I found it impossible to recognize them when but a short distance away."

We have thus decisive evidence that the black and white coloration of the guerezas protects these animals by a close resemblance to their inanimate surroundings. There are, however, certain smaller mammals with a

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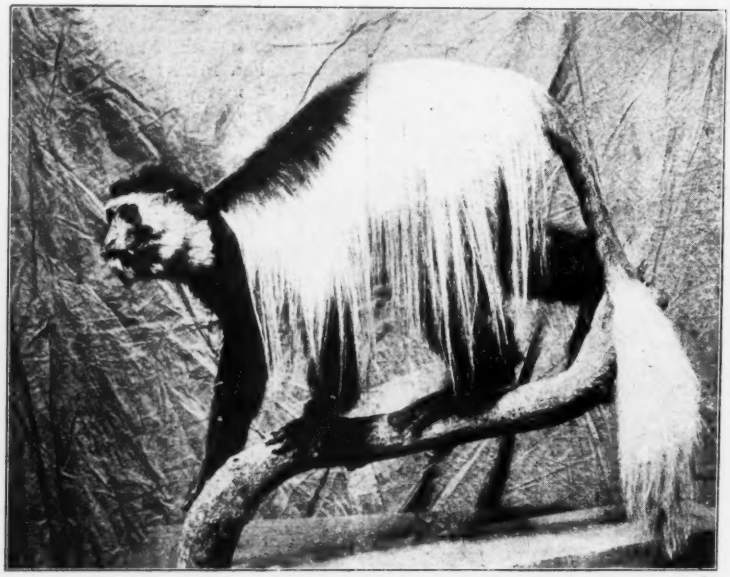
similar type of coloration, in which the startling contrast of black and white seems to be for the purpose of rendering them conspicuous; and as some at least of these creatures are endowed with a most disgusting odour, their conspicuousness has been regarded as warning other animals from attacking them. The best known of these creatures are the ill-famed American skunks, which are in the habit of stalking over the Argentine pampas in full daylight, with the most consummate indifference to the presence of other and more powerful animals. And anyone who is in doubt as to the cause of this proud indifference should read Mr. W. H. Hudson's account of the terrible and lasting effects of their fœtid excretion, as detailed in "The Naturalist in La Plata." Less familiar is the so-called Cape polecat (*Ictonyx*), an animal of about the same size as an ordinary polecat, but having its fur marked with broad longitudinal bands of blackish brown alternating with white. As this creature is stated to have an odour as disgusting as that of a skunk, there can be little hesitation in classing it among animals possessing "warning colours."

A second musteline (*Pœcilogale albinucha*), from South Africa, is likewise conspicuously banded with blackish brown and white, and thus closely resembles the Cape polecat, for which it might readily be mistaken. Unfortunately, its habits seem very imperfectly known, and it is difficult to ascertain whether it has an odour as powerful as that of its larger cousin. Very probably, however, it has not, and that its coloration is a true mimicry of that of the latter. If this be so, we shall have the pied coloration of the animals above mentioned attributable to three distinct causes. In the case of the guereza it affords protection, from its resemblance to inanimate surroundings; in the skunk and Cape polecat it serves to warn other animals from attacking a noisome beast, which is thereby protected; while the South African weasel enjoys immunity from attack on account of its being mistaken for the similarly coloured polecat.



The Guereza (*Colobus guereza*).
From a Photograph of a Specimen in the British Museum (Natural History).

A WELL-LOVED HAUNT.

By Harry F. Witherby.

Of all the delightful places that a naturalist can still find in Old England, give me in winter a certain stretch of lonely mudflats, and in spring the wild and beautiful New Forest.

The two places could not be more unlike, yet there is something which makes them akin—in both one feels alone with wild nature, and in this lies a great charm.

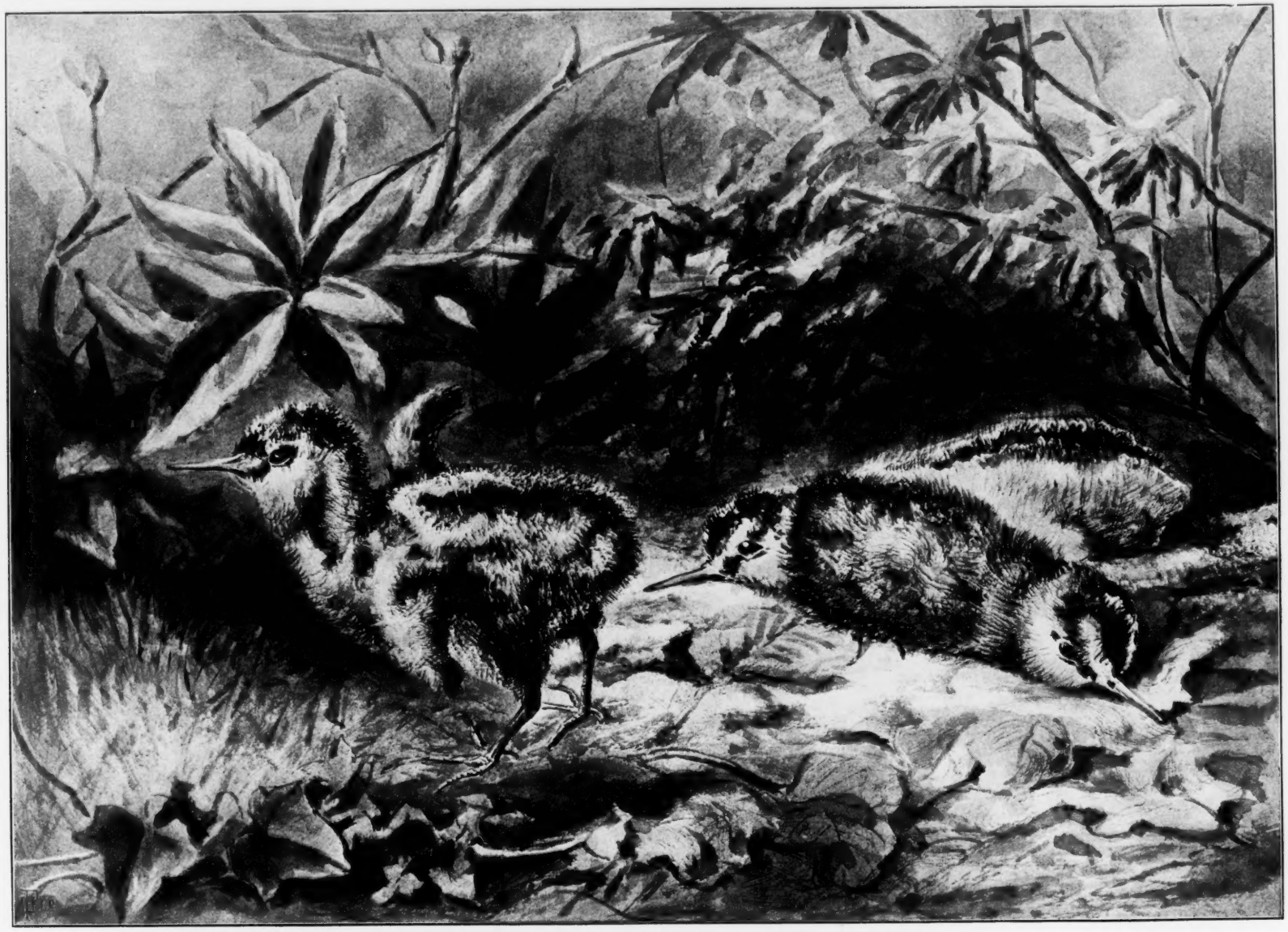
Towards the end of April last I spent a few days with some friends in the New Forest, in haunts well loved and long known; and it is my present intention to write of a few of the birds we saw in the course of a long walk whilst there.

One of the chief delights of the New Forest is its endless variety. In a single morning's walk it is possible to trudge knee high in heather across a glorious moor, to saunter by the wooded banks of a winding stream, to lose one's way in the thickest wood, to wade through a marshy bog, or to pace along the springy turf that grows in the wild untouched glades, and yet to find further on some new scene—some different feature.

Our way led first across a heather-clad moor, some miles in length. We had scarcely gone ten yards when we saw something that looked like a rat running through the heather. We followed after it and found that it was a landrail, or corncrake, as it is sometimes called, which had just arrived, no doubt, from Africa, and a fortnight before its usual time. How unwilling this bird always is to take to its wings! It would have preferred to skulk and hide, but we pressed it hard, and at last it gave up running and flew straight away, somewhat like a partridge.

On reaching the bottom of a dell where a few birch trees were becoming clothed in green—the delicate green of spring—we surprised two greyhen, which, except for their large size, might have been taken for red grouse, as they rushed off with powerful flight. The greyhen and blackcock, known under the general name of black grouse, are by no means plentiful in the Forest, as they doubtless were in days gone by—when, for instance, this moor was one unbroken stretch and had no road intersecting it.

As we reached the margin of the moor we disturbed half a dozen does, which considered for a moment and then sprang off to a plantation of fir and oak bordering the heather. We followed, and climbed the fence which they had taken in their stride. We had advanced some way into this wood, and I had been standing perfectly still in the middle of a grassy ride for about five minutes, listening to the sounds around, when, suddenly, a bird got up behind me. I turned and saw a woodcock rising straight off the ground. Feeling sure that the bird had risen from eggs or young, I ran up to the spot, and looked carefully on the ground. Apparently nothing was there but dead leaves and a few weeds, so I began to examine the leaves one by one, tracing their outline with my eye. In this way I soon discovered a



WOODCOCK CHICKS. (The bird in the foreground is life size.)

From an Original Drawing from Nature.

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beautiful downy young woodcock, of about three days old, lying flat amongst the brown and withered leaves—its colouring of various shades of buff and brown, and its striking markings, harmonizing in a wonderful way with its surroundings. About eighteen inches away from this bird, and within an inch of my foot, were three more, lying in the same position, stiff and motionless, as if dead, but betrayed by their bright black eyes. It is a well-known habit of a great many young birds of this kind, which are able to walk almost as soon as they are hatched, to lie pressed, one might say, against the ground, when they think there is an enemy afoot; and as the colouring of the bird usually, and especially so in the woodcock, matches the colour of the ground, they are exceedingly difficult to see. Moreover, they often sham death. I turned these birds over on their backs, and took them up in my hands, but they still remained stiff and immovable. It was not until they had been handled for some little time that they began to comprehend that they were discovered, and then they were anxious to get away and hide. This shamming of death is evidently only the last means resorted to for escaping discovery, as they first hide in any tuft of grass or little cover that may be near. Indeed, unless one runs up at once to the place from which the old bird has been flushed from her young, they will have effectually hidden themselves. The young woodcock that I found first was separated from the others; it was no doubt the most active of the four, and had got up immediately the old bird flew off, but as soon as it heard me coming it must have crouched down again.

When these young birds were roused, and began to walk, the position of the wings was most noticeable; they were carried stretched out at right angles to the body. This seems a most curious and unaccountable habit, and I know of no other young bird that has it. The advantage of holding the wings in this position is not apparent. It first strikes one that it is for the sake of balancing the bird, but the feet appear large enough to enable a bird three times the size of the young woodcock to keep its balance. Moreover, the young birds are quite able to walk without their wings open, as I proved by putting one in a thick place where it could not do this, and it walked perfectly easily. Neither can the object be to attract the attention of the parent birds, for the shrill, plaintive chirp is amply sufficient for this purpose. Although the advantage of this habit is not apparent, its disadvantages are obvious. It renders the bird very conspicuous, and when walking it can be seen at a considerable distance. Besides this, the wings catch in every little obstacle, such as a blade of grass or a stalk of a fern, and thus the bird is sometimes even tripped up; but as it gets on its feet again it proceeds in the same way, never seeming to learn by experience. There is no doubt a good reason for this curious way of carrying the wings, but it is hard to find.

Another noticeable point in the habits of young woodcocks is that they cannot be induced to run like other young birds—they always walk.

It may be mentioned here that later in the day we found another brood of woodcocks. These birds must have been hatched in the first week of April (a very early date), for they had lost their down and were covered with half-grown feathers. These older birds made little attempt to conceal themselves, and they, too, walked with wings outstretched; and so conspicuous were their large wings that the birds could be seen quite fifty yards away.

In the drawing reproduced in the accompanying plate, the bird (about three days old) in the foreground is seen to be walking away in this characteristic attitude, while two others are shown lying on the ground overshadowed by twigs of sprouting oak. The woodcock* is indeed an interesting bird, and there is much yet to be learnt about it.

After half an hour or so spent thus pleasantly with the woodcock I regained my companions, who were listening to the extraordinary spring song of a green woodpecker. Now a woodpecker of any sort is the last bird from which one would expect to hear a song; yet this bird, whose ordinary note is the well-known harsh, unmusical laugh, seems to be completely carried away by the joys of the awakening spring, and it actually attempts a song! The song is a rambling, indefinite piece of music, but it is soft and not unpleasing, and is suggestive of the highest degree of pleasure. I think this song of the green woodpecker is little known, and, at all events, no mention is made of it in standard ornithological works. I have only heard it two or three times, and on each occasion in April. The bird—and no doubt it is the male—utters it on the wing when chasing its mate. It may be that this song is only used during courtship, and in that case it would seem to be exclusively a love song.

The woodpeckers disappeared, and we walked on out of the plantation and over a stream to visit an old beech tree, in which we had known tawny owls to nest for the past eight years. The bird that has occupied this hollow beech for the last two years is decidedly original in her habits. Usually it is only necessary to tap a tree in which a tawny owl is nesting, or throw a stick up the tree, and out flies the bird. This particular bird, however, will never budge an inch, however hard you tap, or however many sticks and stones you throw up its tree. This eccentricity is a great protection to the nest, for the tree is not very easy to climb, and, unless the bird flies out and thus eggs or young become a moral certainty, most prowling marauders think it not worth while to climb the tree.

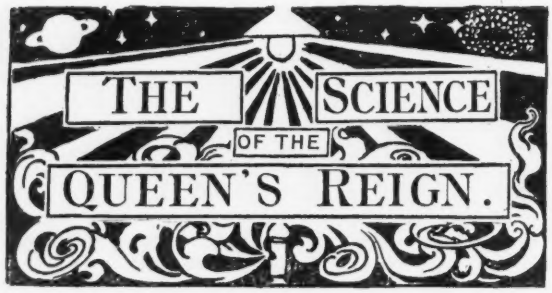
We, however, knowing the habits of this particular bird, scaled the tree, and on looking down the hole, there, sure enough, was the owl. Nothing seems to disturb this bird. On every occasion on which I have visited it, it has appeared to be in a stupor. It allows itself to be turned over on its back, to have the young ones taken from under it—in fact, to be ill-treated in every sort of way short of actual injury. It never resents nor makes any sound or movement, nor does it even deign to open its eyes. This is certainly a very original tawny owl, and I suspect that its eccentricities will prove an advantage both to itself and its progeny.

Among the remains of many a repast in this owl's nest was the leg of a full-grown rabbit. The tawny owl very rarely takes a full-grown rabbit; but with three young ones—which are, indeed, hard to satisfy—to provide with food, we must excuse this small breach in the confidence we place in him as a game preserver rather than destroyer, and set it off against the number of mice and rats which we know are disposed of by our friend the owl.

During our long walk home we passed through the most varied country, and saw many sights which strike the naturalist as especially beautiful. Let me mention one. In a grassy swamp, on the edge of a moor, we found several lapwings' nests. The eggs were laid in a slight hollow on the top of turf-covered heaps raised by moles. The birds, no doubt, found these very convenient nesting sites, for their eggs were thus raised high and dry.

Had we needed further proof of the illimitable resources of our well-loved haunt as a means of whetting the appetite of the ornithologist (we cannot say satisfying, for the ornithologist is insatiable), surely what we found and saw that day was proof for ever.

* *See also* article on "Protective Resemblance," and photograph of a "Woodcock on its Nest," in KNOWLEDGE for March, 1896.



PROGRESS IN MECHANICAL SCIENCE DURING THE QUEEN'S REIGN.

By ROBERT GORDON BLAINE, M.E., Assoc. M. Inst. C.E.

THE British have been called a "nation of shopkeepers," but the right of the Anglo-Saxon people to be called a nation or "nations of handicraftsmen" is at least as clear. In reviewing some of the salient features of the wonderful progress in mechanical arts, appliances, and methods which has characterized the Victorian epoch, it may serve to keep this article within reasonable limits if we confine our remarks mainly to matters which concern ourselves.

The place of our own people in the van of progress has been so prominent that it will not be necessary to go far from home in our review. The progress which has taken place in the various departments of mechanical science may be best appreciated if the matter be put in the shape of contrasts.

FACILITIES FOR TRAVELLING.

Perhaps the most striking changes which have taken place during the last sixty years are those in regard to facilities for travelling. What were the usual means of locomotion when our gracious Queen ascended the throne? We remember that Watt and Stephenson had inaugurated a new era by the evolution of the steam-engine and the introduction of steam propulsion or traction on suitably prepared roads; but the great majority of people travelled on horseback or in horse-drawn vehicles.

Previous to the Queen's ascension the mileage of railways open in the United Kingdom was less than one thousand, and the capital invested less than thirty millions sterling. At present there are, in these islands, upwards of twenty-one thousand miles of railways open, representing a capital of over a thousand millions. In England we have twenty-seven pounds per head of the population invested in railways, against thirty-two pounds per head in Scotland, and a little over eight pounds per head in Ireland. It may be said, then, that our railway system has been developed during the Queen's reign. It is true that the population has increased, and that increased mileage would have been necessary to give even the same population one mile of line; but we have advanced in scientific attainments and conveniences arising therefrom far beyond the mere increase of population. The latter has increased from about twenty-six to thirty-nine millions, whilst railway mileage has increased from one thousand to twenty-one thousand miles. In other words, there are now living in these islands fifteen persons for every ten alive in 1837, but those fifteen have infinitely greater facilities for travelling than they would have had if they had lived then. Thus, sixty years ago there were in the United Kingdom twenty-six thousand persons per mile of railway, whereas to-day there are only one thousand eight hundred and fifty-seven persons per mile. The increase of the urban population has been much more marked than that of rural districts, for during the last decade the former has increased fifteen per cent., whilst the latter has, in the aggregate, only increased about two and a half per cent., many rural districts showing an actual decrease; thus the population of Ireland—chiefly agricultural—has decreased from about eight millions to four and a half. We have this remarkable result, that trades and districts which have been able to avail themselves of the lowering of expense of production and other advantages due to improved machinery and methods, have increased in population at the expense of others not so fortunately situated.

Facilities for travel have greatly changed the currents of public opinion, spreading that species of information which experience alone can impart, and breaking down the barriers of that prejudice and contentment with imperfect conditions which arise from ignorance of the world. In addition to this there is, of course, the more immediate result of increased trade.

The great increase of urban populations has raised some difficult problems, and is in many respects to be deplored. Greater facilities for travelling in and near towns have become necessary, and questions of sanitation—including water supply—have become of vital importance. Nor have the efforts to raise the conditions of life in towns been, in most cases, unsuccessful. Thus the average annual death rate per thousand in London has decreased from about twenty-five in 1840 to nineteen now, amounting to an annual saving of nearly twenty-two thousand lives in London alone. In some provincial towns, however, owing to the increase of noxious trades, the decrease in death rate is not so marked.

Not only in mileage have railways advanced, but the speed, safety, and comfort of travelling have become enormously greater. The earlier third-class carriages were mere rectangular tanks on wheels, open at the top and without seats.

Third-class passengers have proved the dividend payers of modern times, and now this fact is beginning to meet with some recognition and reciprocal benefits. In the early days, however—say, in 1840—third-class passengers did not contribute more than twelve per cent. of the gross revenue of the companies.

The mileage of railways open in the United States has trebled in the last twenty-five years, being now over one hundred and eighty-one thousand miles, representing a capital of over two thousand million pounds sterling.

In facilities for urban and suburban travelling our Transatlantic cousins have still further outstripped us. Whilst we in London have still to be content, to a great extent, with the primitive "bus" and a few horse-drawn tramcars, in the United States there are no less than twelve thousand one hundred and thirty-three miles of electric, and five hundred and ninety-nine miles of cable tramways—scarcely a large village being without its installation. In Brooklyn alone one company owns over two hundred and sixty miles of overhead trolley electric tramlines.

With the exception of small tramways at Portrush and Bessbrook in Ireland, and Brighton, Blackpool, South Staffordshire, etc., in England, we have no electrically driven trams; but the City and South London Railway, with the overhead line in Liverpool, and the two electric lines now being constructed in London, show that we are at last waking up.

TRANSPORT BY SEA.

Here we are on safer ground. In spite of foreign competition, Britain still holds, easily, the premier place in ocean carriage and in shipbuilding.

It was only in 1838 that a steamship, the *Great Western*, of about two thousand tons displacement, commenced a regular service between Bristol and New York, making the passage across the Atlantic in about fourteen days. The advance in the adoption of steam propulsion was so rapid that in 1840 steamers were regularly running to India. Now, eighty-eight per cent. of our ocean traffic is carried on by steamers, and a vessel has recently been launched at Belfast having a displacement of no less than thirty thousand tons; as regards speed, the *Turbinia* torpedo-boat has recently maintained, on trial, a speed of thirty-two and a half knots (about thirty-seven and a half statute miles) per hour; whilst over twenty thousand horse-power for one passenger steamer, with a speed of twenty knots, are not uncommon. Leaving out of account ships of war, the commercial fleet of the United Kingdom and its dependencies in 1837 was represented by about two million five hundred thousand tons, of which only about one hundred thousand tons were steamships, and most of these used steam as auxiliary to sails. Now the registered tonnage of our commercial navy extends to ten million five hundred thousand tons, of which steam vessels are to sailing ships in the ratio of about two and a half to one, and the latter are rapidly disappearing. It is said that in the forthcoming Jubilee naval review, off Spithead, spectators will see, probably for the last time, warships with masts and yards taking part in a naval display.

During the interval referred to, the total of our exports and imports has risen from one hundred and forty million to seven hundred million tons. In 1840 our ships took twenty-seven per cent. of the world's carrying trade; now they take fifty-two per cent., or, including colonial ships, sixty per cent.

To keep pace with the enormous increase in our marine carriage, shipbuilding has advanced by leaps and bounds. This is shown by the following table, giving approximately the figures for ships of all kinds built in the United Kingdom during 1896:—

Place where Vesse's were built.	Gross Tonnage.
Clyde	421,000
Tyne	246,800
Wear	218,400
Tees	113,400
Belfast	119,600
Other Ports (including the Dockyards)	272,000
Total	1,391,200

These figures show clearly the immense importance of this, which may be called the only exclusively British industry, the figures for any other country being comparatively insignificant; but the United States is rapidly improving its position in this regard.

Probably no discoveries have had so great an effect in rendering possible the foregoing advances in railway and marine engineering as the introduction of the Bessemer process of making steel, in 1856, and of the modern Siemens-Martin method. Formerly, wrought-iron rails cost about thirteen pounds per ton; now steel rails of excellent quality can be bought at three pounds fifteen shillings per ton. To Bessemer is due in a great measure the credit of the advance in steel making, though the open-hearth process is now rapidly taking the first place.

The excellent qualities of many recently discovered bronzes and alloys have enabled the modern mechanical engineer to make great advances in regard to the strength of special details, with a great reduction in friction.

CIVIL ENGINEERING WORKS.

The increase in railway enterprise has necessitated the construction of bridges and tunnels of great magnitude. Of these the Forth Bridge in Scotland, the Brooklyn Bridge in America, and the Tower Bridge in London, are among the most remarkable, whilst the St. Gothard and Severn Tunnels are among the greatest.

It is only necessary to remind the reader that the Forth Bridge has spans of one thousand seven hundred feet, bridged by two cantilevers, each six hundred and seventy-five feet long, with a central girder three hundred and fifty feet long, the cantilevers being three hundred and fifty feet deep at the piers and fifty feet at the centre, with a height of three hundred and fifty-four feet above the water, the length of the bridge being over a mile. The contract was let for one million six hundred thousand pounds, but the total cost considerably exceeded this. The Brooklyn Suspension Bridge has a clear span in the centre of one thousand five hundred and ninety-five feet, the height above high water being one hundred and thirty-five feet. The cost was estimated at about three million pounds. The St. Gothard Tunnel is fourteen thousand nine hundred and twelve mètres (about nine and a quarter miles) long, whilst the Severn Tunnel has a total length of about four and a half miles, of which two and a quarter miles are under the tideway of the estuary of the Severn. The Blackwall Tunnel, under the Thames, just opened, with a length of over a mile, constructed at a cost of over one million pounds, is worthy of mention.

The Tower Bridge is, perhaps, the most beautiful work of the kind in existence. The method of opening the bridge to river traffic by the rotation of the bascule leaves or spans—each one hundred and sixty-three feet long, fifty feet wide, and weighing one thousand two hundred tons, about great pivots one foot nine inches in diameter resting on roller bearings—is so well known as to require no detailed description here. The cost of the bridge was about a million pounds sterling exclusive of the cost of land. The average time during which the road traffic is interrupted by the opening of the bascules is only about six minutes, and in many cases three minutes suffices. About eight thousand vehicles and sixty thousand pedestrians cross the bridge per day.

PROGRESS IN MECHANICAL ENGINEERING.

The perfecting of the steam-engine by the use of higher pressures and triple or quadruple expansion, which, with other improvements, has reduced the amount of coal required per horse-power per hour to about one and a half pounds, and the introduction of the steam turbine, are the main features in steam power generation. The gas-engine, and more recently the oil or petroleum engine, have developed with great rapidity. Both the latter may be said to have appeared during the Queen's reign. It is true that Barber, Street, Lebon, and others, towards the end of the previous century, had done something in this field, but the first commercially successful gas-engine was the "Lenoir" of 1860. The great advantages of the gas or oil engine are the facts that it requires no boiler; that it can be started or stopped when required; that, as a rule, skilled attendance is not required; and that it occupies comparatively little space for the power developed. Also a good efficiency is possible, *i.e.*, a large power can be obtained from a small weight of fuel; but in the case of the gas-engine it must be remembered that this fuel has usually to be obtained from the mains of a gas company, and is therefore expensive. The oil-engine has been developed mainly since 1872, and is now rapidly taking the lead as a useful, efficient, and convenient motor.

The use of this motor for the propulsion of road carriages

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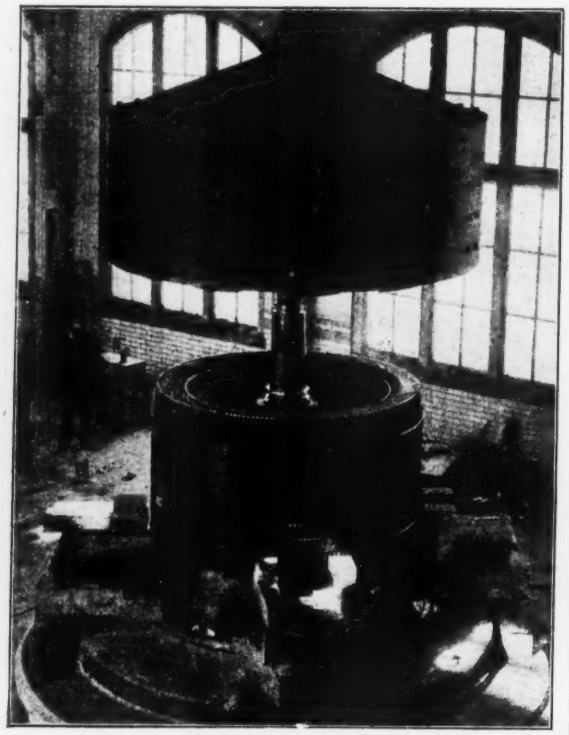
is now attracting considerable attention, though many improvements will be necessary before this method of locomotion comes into general use. It may be stated briefly that the tendency during recent years is towards the specialization of each detail of the work, special machines being used which are capable of doing their particular item of work nearly automatically. This tends to quickness and accuracy in execution, and is necessary to meet the keen business competition now experienced.

Pneumatic machines—*i.e.*, machines actuated by compressed air—are now used to a limited extent, pneumatic tools for caulking, etc., being very successful. For such operations as riveting, punching, etc., water under pressure is the best agent; and hydraulic machinery has come largely into use for these and kindred operations. This is one of the most interesting of the developments of the



Five Thousand Horse-power Alternator at Niagara (during construction).

last fifty years, and our progress here is mainly due to Lord Armstrong.

The introduction of the safety bicycle, and the great reduction of frictional waste of energy which has been effected by the use of ball bearings, with other improvements, have opened up a new and very important field of engineering construction.

Another invention of great domestic and business importance is that of the sewing machine, the invention of Elias Howe, an American.

If we seek for some of the causes of our marvellous advance in mechanical engineering and in processes requiring power, we find it, not so much in our superior skill—though that may exist—as in the fact that we get power cheaper than any other people, owing to the lavish gifts of nature in the shape of coal. Energy (obtained mainly from steam) costs in England about one penny per hundred and twelve foot-tons, whereas the like sum in France only purchases seventy-seven foot-tons, in Germany one hundred foot-tons, and in Italy fifty-three foot-tons.

PROGRESS IN THE INDUSTRIAL USES OF ELECTRICITY.

In the applications of electricity to the useful arts one of the most important points to consider is the generation of current. Early methods of obtaining current by the chemical decomposition of certain metals and liquids have very little interest for us now. To Dr. Faraday, who worked so successfully from 1831 to 1840 in this field, is due the great discovery that a current could be induced or set up in a closed circuit by moving a magnet near it, or by using, instead of a magnet, a conductor conveying a current of varying strength. This great discovery, that a current is induced by moving the wire conveying it in a magnetic field of varying strength, is the principle taken advantage of in the modern dynamo machine, which generates—or rather separates for use—most of the electric energy employed in industrial operations. The work of Faraday, Deprez, Siemens, Holmes, Thomson, Ferranti, and others, is so well known as to require no recapitulation. Suffice it to state that the machine has now been brought to a high stage of perfection and efficiency. The general introduction of the electric light (due to the researches of Sir Humphry Davy and others) is an application of great importance, and forms a prominent feature in the industrial progress of the last few years. Applications of current to mechanical operations have already been referred to, and now seem to be opening up a new era of progress.

The author of the first successful electric motor is not known, but the period of successful development agrees closely with that under review; for in 1838 one of the first successful attempts was made by Jacobi, who used an electric motor to propel a boat on the River Neva.

Robert Davidson, of Aberdeen, in 1839, worked a lathe in a similar way; but we must come down to Faraday's time in order to find a successful motor utilizing current generated by a dynamo.

The employment of water power at Loch Ness for the electric production of aluminium from beauxite, and the immense works of the Niagara Falls Power Company at Niagara, are evidences that we are at last becoming alive to the possibilities of natural sources of power, and of electricity as an agent for its transmission. The electric telegraph is, however, probably the most important use of electricity inaugurated during the Queen's reign. Whilst we have been slow, in this country, to avail ourselves of the advantages of electrical transmission and distribution of power, in telegraphy we have been always well to the front.

When Her Majesty ascended the throne, telegraphy—especially submarine telegraphy—was in little more than the experimental stage. It is true that Schilling had, in 1812, exploded mines across the River Neva by electric current conveyed under the water by insulated wires; but little seems to have been done in submarine telegraphy until about 1838, when Colonel Pasley, R.E., made experiments at Chatham which proved that telegraphy was possible through wires laid under water.

The discovery by Oersted, in 1819, that a needle is deflected if placed near a wire conveying an electric current; those of Arago, Ampère, and Sturgeon (1820–26), showing the magnetization of a needle by the passage of a current round it; that of Henry in 1830, in which a bent iron bar was made, for the time being, into a magnet by the passage of a current in a conductor enveloping it; and the further discovery that this magnetizing effect was not

sensibly diminished by the passage of the current through a long conductor—paved the way for the introduction of the electric telegraph, which, however, is a product of the Victorian era.

Baron Schilling, about 1838, used the deflections of needles to right and left as a means of signalling; but Gauss and Webber seem to have introduced the use of a single needle, their apparatus being exhibited before the Society of Arts in Edinburgh in the November of the year in which the Queen ascended the throne.

The English electric telegraph is in a great measure due to William Fothergill Cooke. In the latter part of 1836 Cooke had the satisfaction of witnessing a trial of his key and needle telegraph on the Liverpool and Manchester Railway. In 1837, with Prof. Wheatstone, of King's College, London, he set to work to perfect his apparatus and to make it less complicated: the result being that in June of 1837 (about the time of the Queen's accession) a practical form of electric telegraphy was patented in England.

In 1840 Prof. Wheatstone showed, before a Committee of the House of Commons, his apparatus for proposed telegraphing between Dover and Calais.

In 1842 Prof. Morse laid his wire in New York Harbour for the purposes of electric telegraphing; and in 1845 Cornell laid twelve miles of cable in the Hudson River.

The first concession for international submarine telegraphy was granted to Jacob and John Watkins Brett in 1847. The successful development of submarine telegraphy under the lead of Englishmen like the late Sir Charles Bright need not be further referred to; but we may note, in conclusion, that there are now more than thirteen hundred submarine telegraph cables in existence, the total length of which is probably not less than one hundred and sixty thousand miles, the cables varying from a quarter of a mile to two thousand six hundred nautical miles in length. It is notable, however, that whilst there are two hundred and twenty-three cables of between five and fifty miles in length, one hundred and fifty-five are from one hundred to five hundred miles long, and there are only eight the length of which exceeds two thousand miles.

The telephone is, comparatively, in its infancy, yet its progress so far has been much more rapid than that of its sister the electric telegraph. Doubtless, its being and wonderful capabilities are due to the researches of Wheatstone (1821, etc.), Page (1837), Bourseul (1854), and especially Reis (1868). The speaking telephone was, however, only patented (in the United States) by Graham Bell (a Scotchman, naturalized as an American citizen) on February 14th, 1876. Elisha Gray, an American, applied on the very same day as Bell for a patent for a similar apparatus. A compromise was effected between the rival claimants, and to Graham Bell is usually given the credit of the invention.

Mr. Preece, at the meeting of the British Association, held at Plymouth, in 1877, exhibited, for the first time publicly in England, Bell's telephone. The carbon transmitter is due to Edison, and Hughes' discovery of the microphone, in 1878, has done probably as much towards the perfection of the telephone as Bell did towards initiating it. These two triumphs of the latter part of the Victorian age, the telegraph and the telephone, have done more for the advancement of business, and even the spread of information and the reign of peace, than any other two discoveries which the remarkably fertile years of Her Majesty's reign have produced.

It is a remarkable fact that the two countries which are now competing most keenly with us in the industrial race—especially in those departments allied to engineering—are Germany and the United States: two which have for many years been in the van in the matter of providing facilities for education in matters pertaining to the industrial arts.

In the matter of technical education we are behind Germany now, and it is doubtful whether, on present lines, we will greatly better our position in the future; and whilst we rejoice in the phenomenal progress of the last sixty years, our self-congratulation is tempered by some misgivings as to the future.

CAN THE DEAF APPRECIATE MUSIC?

By DR. J. G. MCPHERSON, F.R.S.E.,
Late Mathematical Examiner in the University of St. Andrew's.

PROFESSOR McKENDRICK, of Glasgow University, has laid before the Royal Society of Edinburgh the results of some experiments which indicate that the deaf can be made to understand some of the elements of music. They have been deprived of the ordinary sense of hearing, yet their senses of sight, smell, and touch are intensified. They can understand to some extent what a friend says by observing the motion of the lips. But, according to Prof. McKendrick, the deaf may yet have the means to appreciate music.

The Professor showed us, a year ago, in the Royal Society of Edinburgh, a beautiful experiment, which originated his new discovery. He suspended a microphone transmitter over a phonograph when the latter was in motion and giving out tones, and showed that the variations in resistance in the former produce such attractions in the current flowing through it to the coils of an electro-magnet as to mechanically record these variations. Continuing these experiments, he introduced the microphone transmitter into the circuit of the primary coil of the induction machine along with four Obach's cells (Q type). He carried the terminals of the secondary coil to two strips of platinum foil, immersed in two shallow vulcanite troughs, containing a ·75 per cent. solution of common salt or sulphuric acid (1 : 10 of water). He was then astonished to find that when the phonograph was in motion and emitting notes of music, an electric thrill was felt in his fingers which corresponded to the rhythm, time, and intensity of the tune given out by the phonograph. By carefully graduating the strength of the induction shocks, he distinctly felt each successive note and each chord of the music. This discovery at once suggested to him that those whose fingers are exceptionally sensitive because of the defect in one of the senses would appreciate more keenly the meaning of the thrills from the insulated trough, as strange music of a kind. The sensory nerves of the skin can appreciate all the variations in resistance in the microphone transmitter suspended over the phonograph, discoursing familiar tunes. The only difficulty is the regulating of the strength of the stimulation. If it is too strong, muscular twitchings are excited, and the rhythm of the music is blurred; but when regulated, the "thrill" is carried to the brain with a correct impression of the sound.

Now, what structures in the skin are stimulated by such thrills from the electric connection? To the skin are referred at least two well-defined sensations—touch and temperature. Touch is a sense of pressure, and is connected with various kinds of touch corpuscles; but no end organ has yet been discovered for the sense of temperature. It is very curious to be assured by experiment that there are "hot" spots and "cold" spots on the fingers. If a copper point, of the temperature of the skin, be applied to a cold spot on the finger, a cold sensation is excited;

XUM

whereas if the same copper point be applied to a hot spot, a warm sensation is easily recognized. Accordingly, on the fingers we have touch spots—hot spots and cold spots. Generally speaking, the temperature spots are insensitive to pain; in fact, though a fine needle be pushed into a hot or cold spot—apart from being a pressure spot—no pain is felt. If a metallic point, conveying a current of electricity, be carried along the surface of the skin, very strange sensations will be felt in its course. There will be cutting-pain points, thrill points, tickle points, and actual dead points.

Prof. McKendrick is puzzled with the effects of rapid induction currents on the skin elements. The currents do not produce pressure in the ordinary sense; nor do they produce sensations of temperature; nor are they of a painful character. So far as he is aware, no observations have been made on the stimulation of sensory skin-nerves, except with reference to the production of reflex acts. But he has been directing his attention to the effects of stimulation of the skin—varying in number, in intensity, and in rhythm—on the brain.

Of course, it is well known that a single stimulus applied to a motor nerve will cause a single twitch, and the distinguishing characteristics of such twitches are equally well known. If the stimuli come in very rapid succession, muscular rigidity is the result. Accordingly, considerable care is necessary in the carrying out of the experiments.

Prof. McKendrick introduced into the circuit of the primary various interrupters—clocks, metronomes, vibrating strings, and tuning forks—to ascertain their effects. These varied in speed from one to two hundred vibrations per second. The terminals of the secondary coil were carried to the platinum foil in the vulcanite troughs containing the salt solution; and he dipped his fingers into the troughs. He could readily mark the successive stimuli up to fifty per second. When the number of stimuli was raised to one hundred and twenty per second, there was a thrill comparable to the effect of very rapid musical beats, causing disagreeable roughness. Above that the effect was of a more solid character, which could not be analyzed into details.

By repeated experiments Prof. McKendrick has established the fact that the sensory nerves of the skin can appreciate electrical stimulations corresponding in number, rhythm, and intensity to the notes or chords of a complicated piece of music. But the stimulation of the skin (so far as is yet known) can give no accurate appreciation of the pitch of individual tones; although, when stimulations are comparatively few in number, the sensation is rough, and different from the continuous sensation occasioned by very numerous stimulations. Nor can the stimulation of the skin give any idea of the quality of tone. He cannot detect any feeling like that which leads us, when we intelligently listen to music, to be, as it were, searching for the tones that determine scales. Still, there remain the elements of rhythm, and this includes the duration of individual tones, and the intensity of tone. As to time and duration, he has found the sensations quite distinct. After careful and repeated tests of the varieties of simple and compound times, he has found no difficulty in distinguishing the one from the other.

It is from these experiments that the Professor is sanguine about influencing the brain of the deaf through the fingers, so as to make them understand some of the elements of music. Yet he admits that, so far as his experiments guide his judgment, the music thus transmitted to the deaf will be, as it were, "on one plane." Several deaf persons on whom he has experimented have appeared to be startled with the new sensations, and when it was explained to them that there was something of these new sensations in music they apparently had increased pleasure, because they could more intelligently sympathise with those who had the coveted sense of appreciating music. To some extent, then, the deaf may be able by refined thrill transferences to follow Congreve when he says:—

> "Music has charms to soothe the savage breast,
> To soften rocks or bend a knotted oak;
> I've read that things inanimate have moved,
> And, as with living souls, have been inform'd
> By magic numbers and persuasive sound."

There is, too, a correlation of the senses which demands more close attention in scientific inquiry. Sensations of sound affect those of colour. Raff, an eminent musical composer, said that he saw the colour of the flute to be blue, the hautboy yellow, and the cornet green. Sounding a tuning fork may cause a colour to be seen more vividly. Smells, tastes, touches, may influence sounds; a loud sound may appear more subdued when one shuts his eyes. All are familiar with the close relation of sight and taste. In the same way smell affects sounds, and tastes influence colours. If a very bright light be made to fall upon the skin of the hand, the sensitiveness to temperature is increased. If the skin be excited by quiet currents of electricity, pleasurable sensations may be produced; if regulated stimuli be applied to the fingers through the isolated troughs, duration, time, and rhythm may be recognized. May we not, then, send nervous impulses through the finger-tips which may radiate to the cerebral centres of the ear, and thus excite processes resulting in something like the consciousness of music? Certainly to those who once heard, and had lost their hearing by an accident, the sensation can be more easily assimilated; in them electrical stimulations of the skin can more easily awaken a kind of cerebral music, which will remind them of what they once so much enjoyed, touching the finest strings that reach the heart; music—

> "Which they have loved long since, and lost awhile."

THE AGE OF MOUNTAINS.—III.

By Professor J. LOGAN LOBLEY, F.G.S.

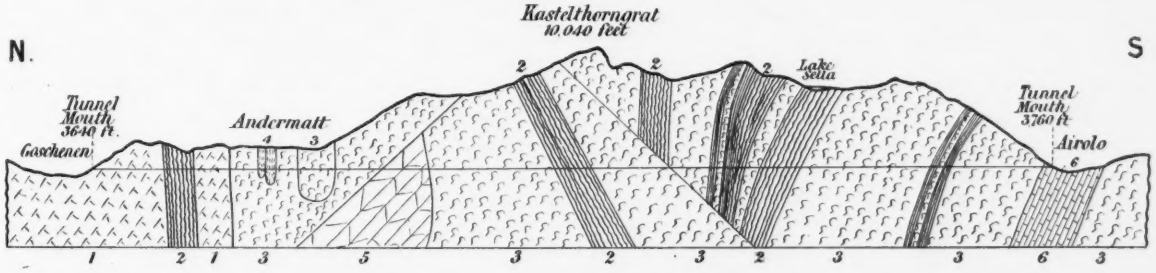
TOWERING far above all other groups and ranges of mountains in the European area, the Alps form the greatest and most conspicuous physical feature of its land surface. With a summit of fifteen thousand seven hundred and thirty-two feet above the level of the sea, and stretching for five hundred miles without a gap of less elevation than six thousand feet, they form, with their lateral extensions (the Pyrenees on the west and the Balkans on the east), the great wall dividing the main mass of the continent from its southern peninsular portions. If the Jura, the Apennines, and the Carpathians be regarded as offshoots—which they really are—we find comprised in one great mountain system all the principal ranges of Europe, with the exception of the Ourals, the Scandinavian chain, and the sierras of the Iberian peninsula.

Of the central portion of this great mountain system—the Savoy, the Swiss, and the Tyrolese Alps—the petrological structure has long been generally known. For this we are indebted to the labours of Boué, Brogniart, Elie de Beaumont, Geslin, Heer, and to our own great geologists, Sir Roderick Murchison and Sir Charles Lyell—the last-named of whom, by his masterly reasoning and brilliant exposition, has removed much obscurity. But a more detailed knowledge of the structure of the Alps

has been given by the great tunnelling operations of later years, and by the observations of Sharpe, Favre, Stapff, Heine, Bonney, and others; and the geological age of the newest of the rocks has only been satisfactorily established in recent times.

The granitic, gneissic, and schistose rocks forming the axis of the high Alps were, in the old days of geological science, considered to be purely Igneous, and what was then called "Primitive" rock, the oldest and first consolidated rock, as was supposed, from which were derived all the Sedimentary rocks; and the upheaval of the range

FIG. 1.—SECTION THROUGH MOUNT ST GOTHARD ALONG THE LINE OF THE TUNNEL. (AFTER STAPFF.)

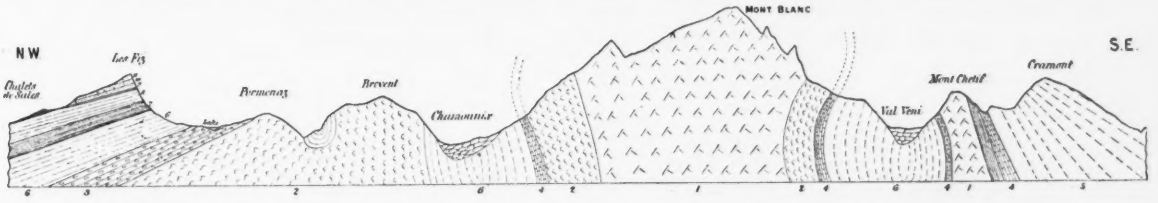


1. Granites. 2. Gneiss. 3. Schists with Hornblende Rock. 4. Cipoline. 5. Serpentine. 6. Dolomite.

was ascribed to sudden, violent, and paroxysmal efforts of nature, which it was contended acted with much greater intensity of force in the past than at the present time. Our knowledge now, however, leads to a quite different conclusion as to the age of the Alps, for upon the Crystalline rocks forming their core we find that Jurassic, Cretaceous, and Eocene strata repose at high levels, and into each and all of these rocks the granitic and gneissic rocks penetrate. Thus is clearly proved the post-Cretaceous age of these once supposed fundamental and Primitive rocks, since we see that they were in a fluid or plastic state in the Eocene period, and under vast thicknesses of strata, into which the fused mass penetrated; and it is not improbable that Sedimentary rocks of the same age as some of the fossiliferous and well-known deposits of England furnished the material. At the commencement of the Eocene period, therefore, the Alps were not in existence, though elevated land may have occupied their place in previous epochs, and what now forms lofty summits was deeply buried beneath the floor of the sea.

But the Alps as we know them, like other mountain ranges, were not formed by one elevatory movement only, for there is evidence of several, the final one being of very late geological age. On the flanks of the Alps, and having an elevation of no less than ten thousand feet, are found Eocene strata, while the well-known Righi and the Rosberg expose beds of conglomerates of Oligocene age of vast thickness. An upheaval of the Alps must consequently have taken place long after the close of the Eocene period. The previously upheaved land, the Eocene Alps, had been slowly depressed for thousands of feet during the slow accumulation of the vast beds of water-rolled pebbles, forming the "Nagelfluh" of the "Molasse," and then, subsequently, again upheaved, until the pebble-beds were high above the waters from which they had emerged and in which they had been accumulated. There is evidence, indeed, that the Alps of Dauphiné are in geological age post-Cretaceous, the Julian Alps later than the Lower Eocene, the Western and Northern Alps post-Miocene, and that the highest and principal chain is the newest of all, or post-Pliocene. Thus it was this final upheaval that gave to Europe the grand range of the Penine Alps, with the giant peaks of Mont Blanc, Monte Rosa, the Matterhorn, and the Great St. Bernard. As has been pointedly said: "It may well appear a startling proposition to learn that the clay of London was in course of accumulation as marine mud at a time when the ocean still rolled its waves over the space now occupied by some of the loftiest Alpine summits"; yet there is no room left for doubt that such was the case. And in the same presidential address from which the foregoing is taken, Lyell says that "not only the upheaval of the Alps, but all the principal internal movements, dislocations, inversions, and contortions of the strata are subsequent to the Nummulitic deposits, and had not, therefore, even commenced till great numbers of the Eocene vertebrate and invertebrate animals had lived and died in succession."

FIG. 2.—SECTION THROUGH MONT BLANC FROM LES FIZ TO CRAMONT. (AFTER FAVRE.)



1. Granite (Protogene). 2. Crystalline Schists. 3. Schists with Conglomerate. 4. Dolomite. 5. Triassic or Jurassic. 6. Jurassic. 7. Neocomian. 8. Urgonian. 9. Chalk. 10. Nummulitic Limestone. 11. Grès de Taviglianaz.

To a post-Pliocene upheaval must also be assigned the elevation of a portion of the Jura Mountains, the Secondary rocks of which are so conspicuously folded; but the more southern Juras are probably of the preceding epoch, while

part of the range may have been raised at a still earlier period.

The geographical relationship of the mountains of Switzerland to the other ranges of the great Southern European system is, as might be presumed, not the only one. The western range, the Pyrenees—with, like the Central Alps, a granitic axis on which repose Silurian, Jurassic, and Cretaceous strata—is partly made up of Nummulitic Limestone, the same formation that is so largely represented in the Eocene portion of the more lofty eastern range. It may, therefore, be concluded that the same great elevatory movement which raised the Alpine region of Switzerland subsequently to Middle Eocene times affected also the Pyrenees; and that this range, rising in the Pic de Méthou of the Maladetta Mountain to a height of eleven thousand one hundred and sixty-eight feet above the level of the sea, was then formed as a great European range.

Connected on the east with the Swiss Alps by the Rhœtian, Noric, Carnic, and Dinaric ranges, are the Balkans, which, although with a main chain extending almost due east from near Sophia to the Black Sea, do not consist of ranges having one general direction, but of a number of mountain groups and ridges irregularly radiating from the mass called the Etropol Balkans. In Mount Olympus (nine thousand seven hundred and fifty feet) is the highest mountain of the Balkan peninsula; but Muss-alla (nine thousand five hundred feet), at the north end of the Despato Dagh or Rhodope Mountains, is the loftiest summit of the Northern Balkans—the Balkans proper. It is only comparatively recently, by the work of Dr. Hochstetter, that more than a very general knowledge of the geology of these mountains has been obtained. Their interior masses consist largely of Crystalline and Metamorphic rocks, granites, and schists; and one of the principal mountains, Mount Vitosh, is a mass of syenite with much magnetic ironstone. The unmetamorphosed Sedimentary rocks overlying the Crystalline schists are largely Cretaceous, Hippurite Limestone being conspicuous, especially in the western mountains, where Mount Dinaria is but one great bare mass of this white rock. The Middle Eocene Nummulitic Limestone is also an important formation, and on the Despato Dagh, Miocene beds occur at a height of from two thousand to three thousand feet. From this there is justification for assigning to these mountains a post-Miocene formation, and Elie de Beaumont gives a much later age—post-Pliocene—to the Eastern Balkans.

The Italian branch of the great Alpine system, the Apennines, is joined to the lofty central ranges by the Graian, Cottian, Maritime, and Ligurian Alps, and stretches southwards in a continuous chain of mountain ridges for six hundred miles. The Apennines are of moderate elevation and culminate in Monte Corno (nine thousand five hundred and seventy-four feet), the summit of the Gian Sasso d'Italia. They differ from the Alps in not having a granitic and schistose axis, the great mass of the range consisting of Jurassic and Cretaceous limestones, though in the southern portion Crystalline Metamorphic rocks appear, and in the most northern Apennines rocks of Carboniferous age occur. The Secondary rocks have, however, been so altered in many localities that they yield a great variety of beautiful marbles, the pure white saccharine marble of Carrara, of Jurassic age, being a notable example. The great Cretaceous Hippurite Limestone forms enormous mountain masses in the Abruzzi. Overlying the Secondary rocks in large areas are Eocene limestones and Miocene beds, and flanking the central ranges are low hills of Pliocene deposits of an estimated maximum thickness of one thousand five hundred feet. It is therefore evident that the Italian peninsula was greatly depressed in Pliocene times, and that we owe the Apennines as a prominent feature of Southern Europe to a post-Pliocene upheaval, subsequent to which again was the commencement of the formation of the volcanic mountains Vesuvius and Ætna.

Turning to the north, the great Carpathians form a semicircle of nearly nine hundred miles, but united to the Noric range of the Tyrolese Alps by the Bakony Waldauth. They consist of the North Hungarian mountains on the west, the Waldgebirge forming the middle, and the Sieburgen in the Eastern Transylvanian region. The Tatra group is an immense mountain mass at the north of the bow, and gives in Gerlsdorf (eight thousand seven hundred feet) the summit elevation of the whole range. The Carpathians are almost without glaciers, and have large masses of volcanic rocks, both trachitic and basaltic. With a general granitic and schistose core, the south-eastern ranges largely exhibit Palæozoic rocks, while the north-western granites are overlaid by rocks of Triassic and Cretaceous age. Eocene Nummulitic limestones and coal-bearing beds of Miocene age attest the extension of the Central European Miocene depression to the Carpathian region, and the final elevation of the range in post-Miocene times.

When, however, we leave the great Alpine mountain system, and turn our attention to Northern Europe, we find more ancient mountains, for both the Ourals and the Scandinavian ranges were high above the waters of the Palæozoic sea. The Ourals consist largely of Metamorphic rocks, like most of the other great mountain ranges of Europe, but these are not covered in any part by beds of later date than the Carboniferous. These rocks, almost horizontal and undisturbed in the plains to the east, are uptilted when they reach the mountains, and are greatly dislocated and contorted throughout the range; and at the base of the mountains, where the Carboniferous strata begin to be inclined, the Permians are seen, but they are undisturbed, and it is evident they were not affected by any uplifting agency. Evidence is thus afforded that the Ourals were elevated between the commencement of the Carboniferous and the close of the Permian epochs.

The Norwegian mountains, extending the whole length of the Scandinavian peninsula, appear to be very much older still, for, in the opinion of the late Prof. Sir Andrew Ramsay, there is sufficient evidence of their pre-Devonian existence. The Scandinavian mountains may therefore be considered to be the oldest of the great mountain ranges of continental Europe.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

DR. CROLL'S THEORY OF GLACIATION.

To the Editors of Knowledge.

Sirs,—Your notice of Dr. Croll's life in the April Number induces me to ask space for a few remarks on his theory of glaciation, because, to my mind, neither he nor Sir Robert Ball have dealt with the real problem in an exhaustive or satisfactory manner.

We receive a little more heat from the sun in the course of the year during the period of maximum eccentricity than when the eccentricity of our orbit is nearly at a minimum. The cumulative effect of this annual increase continued for centuries would probably considerably reduce the extent of our snow-caps or ice-caps. However, I am

satisfied for the present to neglect this element, as Dr. Croll does; and then the problem will be the following:—Is an equal or an unequal distribution of the total amount of annual heat received at any place more favourable to the formation of a *permanent* ice-cap?

Of course there are regions where considerable quantities of snow and ice may now be met with in winter, where, with an equal distribution of the annual heat, there would be no snow or ice at any season. But how is it proved that by any distribution of this total annual heat a *permanent* ice-cap can be formed in these regions?—for it is with such permanent ice-caps that we are dealing. The ice-cap, according to Croll, would never be melted if the eccentricity and perihelion did not change. On the other hand, there are probably regions in which, if the total annual heat was uniformly distributed, the ground would never be free from snow and ice; whereas the present unequal distribution enables the ground to be cleared and vegetation to grow for a short time during summer. Dr. Croll insists a good deal on the shortness of the summers at the period of maximum eccentricity and winter aphelion; but how is it proved that a given quantity of heat will produce less effect in melting snow and ice when compressed into a short period than when spread over a long one? Short as the summers may have been at this period, we received more heat from the sun during them than during the longer summers experienced at present. Why, then, should they not prove more efficacious in melting snow and ice? If we received in a single day the entire heat which is now spread over our whole summer, I would expect to find the glaciers and snow-caps reduced to an unprecedented extent on the following morning. It is said that some volcanic mountains have been cleared of snow in a single day before an eruption. Generally speaking, I think a given quantity of heat will produce the greatest effect when compressed into the shortest time. At all events, it is only when time affects the total quantity of heat that it becomes an important factor in the result. If I am wrong in this, I hope some disciple of Croll will set me right, and show that an amount of heat equivalent to a given number of foot pounds will melt more snow when absorbed in twenty-four hours than when absorbed in the same number of minutes, or else that a smaller proportion of it will be reflected without absorption when the time is lengthened.

Dr. Croll's theory seems likely to be refuted otherwise. The amount of post-glacial erosion is regarded by many geologists as too small to be explained by a glacial period as remote in date as that of Dr. Croll. On this subject I am not competent to offer an opinion, but on reading over the arguments in favour of the theory, I feel surprised that their inconclusiveness has not been more generally recognized.

The entire subject is too large to be dealt with in a letter like the present, but I do not think Croll has proved either that we would not in the British Islands receive enough heat during each short hot summer to melt the snow and ice formed during the previous winter, or that this heat would be diverted to some other purpose and would leave the snow and ice (or some of it) unmelted when the next winter came on.

That the diversion of the Gulf Stream would deprive us of a good deal of heat must be admitted, but I do not think Dr. Croll has proved that it was in fact diverted at this period. Indeed the continuance of the Gulf Stream during the glacial period seems to afford the best explanation of the limits of glaciation on the opposite shores of the Atlantic.

W. H. S. Monck.

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—Continuing the maximum of *o* Ceti, this apparition may be placed on any day between 1896, December 16th, and 1897, January 10th, and the differences will hardly exceed three steps; but the star increased a step or two between these dates. My record is as follows:—

1897.	Mag.	1897.	Mag.
January 7	4·1	February 6	5·0
„ 8, 9	4·3	„ 12	5·3
„ 11	4·4	„ 13	5·05
„ 13	4·5	„ 16	5·4
„ 17	4·4	„ 21	5·2
„ 18, 19, 20, 21, 22	4·5	„ 23	5·0
„ 25, 26, 27 ...	4·6	„ 27 ...	Very red
„ 28, 29, 30, 31 ...	4·7	March 6, 7	5·3
February 2.	4·7	„ 10	5·4

Since the last observation the star, owing to rain and cloudy weather, has been invisible, and another view of it this season is hardly probable.

From December 15th to March 10th Mira wavered in light, and much oftener than it changed in colour. Its apparent unsteadiness in light may, by those so disposed, be smoothed over or charged to errors of observation, but I incline to believe the fluctuations were real.

As indicated in Knowledge for October, a minimum of R Scuti at 7·5m. was reached on July 26th, and a maximum of 5·4m. followed on August 29th. These phases were in reverse order of production. The succeeding phases were faintly marked, for from August 30th to November 1st the star varied less than a magnitude, but during this interval of two months it was very red. On the latter date it broke away, falling from 6·0m. to 7·0m. on November 8th. After this it was not seen, having passed too far west for observation, but it is reasonable to suppose that it reached a minimum on November 10th, the date given for that phase in the "Companion."

Verification of this was interesting, as it would show that it had returned to its old elements after being dropped from the Catalogue by Dr. Chandler and the "Companion."

But R Scuti is now a morning visitor, with which the moon interfered in the last week of January, but I found it near the horizon on the morning of February 2nd. My record since is as follows:—

1897.	Mag.	1897.	Mag.
February 3	6·6	February 27	5·4
„ 10	6·4	March 2	5·9
„ 16	6·2	„ 6	5·9
„ 24	5·8		

showing a maximum in regular order from the old epoch.

Further observations—until R Scuti appears in the evening—are impracticable, as daylight comes on too early.

David Flanery.

Memphis, Tenn., U.S.A.,
19th March, 1897.

Obituary.

By the death of Mr. A. D. Bartlett, on the 7th May—a man who could claim acquaintance with all the leading zoologists of his age—visitors to the Zoological Gardens in Regent's Park will miss a familiar figure and genial superintendent, ever ready to impart information. Mr. Bartlett was born in 1812, and was appointed to his responsible position at the "Zoo" in 1859, where he continued to discharge his duties till within a few weeks of his death at the great age of eighty-five years. He was a man of much resource, as well as of immense general knowledge, and his unique experience in the treatment of wild creatures of all kinds in captivity was invaluable to

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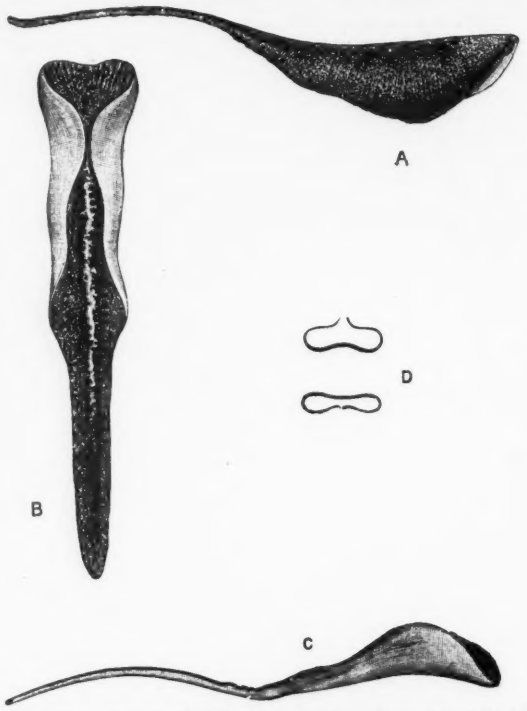
the Zoological Society. Many a dumb animal's life was saved in time of jeopardy by his prompt application of a common-sense remedy. We are indebted to him for many instructive and valuable papers. He described several new species of different genera, and was the first to describe the annual shedding of the horns in the American prong-horned antelope. Mr. Bartlett did much to enlighten us on the divergence of habit in allied species, the peculiar traits of individuals, and the effect of confinement in the modification of instinct; and he was wont to say that the more the treatment of an animal in confinement was made to conform to its natural conditions of life, the better was it for its health and longevity.

We regret to announce the death of Edward James Stone, F.R.S., Observer and Director of the Radcliffe Observatory, Oxford. He was born in London, 28th February, 1831, and in 1856 obtained a scholarship at Queen's College, Cambridge, graduating as fifth wrangler in 1859, and was forthwith elected to a fellowship. Becoming Chief Assistant at Greenwich Observatory in 1860, he succeeded Sir Thomas Maclean, ten years later, as Her Majesty's Astronomer at the Cape, and in 1879 he turned homewards to fill the post of Radcliffe Observer. Dr. Stone will, perhaps, be best remembered through his two star catalogues; the first, for the epoch 1880, including nearly twelve thousand five hundred southern stars, and for which the French Academy, in 1881, bestowed on him the Lalande Prize; the second, termed the "Radcliffe Catalogue for 1890," giving the places of six thousand four hundred and twenty-four stars situated between the Equator and twenty degrees of south latitude, thus completing a most useful survey of the austral skies. For his re-discussion of the observations of the transit of Venus in 1769, he received, in February, 1869, the gold medal of the Royal Astronomical Society. The value of the sun's distance, however, which he then arrived at—ninety-one million seven hundred thousand miles—is now known to be about a million miles too small. On December 8th, 1874, Dr. Stone watched the first of the eagerly anticipated nineteenth century transits of Venus, and ably organized the Government expeditions to observe the second of the pair eight years later. His report, presented in 1887, contained an elaborate inquiry into the baffling phenomena of "contacts," and gave, as the upshot, a parallax of 8·85″, corresponding to a distance of the earth from the sun of ninety-two million five hundred and sixty thousand miles.

Notices of Books.

The Cambridge Natural History. Vol. II. *Worms, Rotifers, and Polyzoa.* By various Authors. (Macmillan.) Illustrated. 17s. "The Cambridge Natural History" has, perhaps, not realized the popular character promised by the prospectus, but it has found a foremost and permanent place among works designed to present a connected view of the organic world to the cultivated mind, and to exhibit the most important facts and consequences now known to natural science. By no stretch of the imagination can the present volume be called a work for the general reader: it is a volume for the student of science, and by him will it be welcomed. The subjects and authors are as follows: Flatworms and Mesozoa, by F. W. Gamble; Nemertines, by Miss L. Sheldon; Threadworms and Sagitta, by A. E. Shipley; Rotifers, by Prof. Marcus Hartog; Polychaet Worms, by Dr. W. B. Benham; Earthworms and Leeches, by F. E. Beddard; Gephyrea and Phoronis, by A. E. Shipley; and Polyzoa, by S. F. Harmer. The writers are high authorities upon the assemblages of animals with which they respectively deal, and their contributions claim the attention of all who are professed naturalists. The whole volume is a marvel of careful writing, brilliant illustration, and good printing. There is, indeed, no similar work in existence containing text more trustworthy and instructive, or clearer figures than are given in the volume before us. As an instance of fine



Leptoplana in the act of Swimming. A. Seen from the right side during the downward stroke (the resemblance to a skate is striking); B, from above, showing the upward stroke and longitudinal undulations of the swimming lobes; C, side view during the upward stroke; D, transverse section of the body during the stroke.
From *The Cambridge Natural History*, Vol. II. (By permission of Messrs. Macmillan.)

drawing the diagrammatic view of the structure of *Leptoplana tremellaris* as a type of the Polycladida would be difficult to excel. All earnest students of natural science should see, and, if possible, possess, the monumental work now in course of publication by Messrs. Macmillan.

The Gases of the Atmosphere: the History of their Discovery. By Prof. W. Ramsay, F.R.S. (Macmillan.) Illustrated. 6s. "To tell the story of the development of men's ideas regarding the nature of atmospheric air is in great part to write a history of chemistry and physics." These are Prof. Ramsay's opening words, and they serve to define the spirit in which the present work has been written. The experiments and speculations of Boyle, Mayow, and Hales; the discovery of fixed air (carbon dioxide) by Black, and of mephitic air or phlogisticated air (nitrogen) by Rutherford; the discovery of dephlogisticated air (oxygen) by Priestley and by Scheele; the overthrow of the phlogistic theory by Lavoisier; and Cavendish's investigations of nitrogen and water, are described by Prof. Ramsay in language easily understood by readers without any special scientific training. It was Cavendish who, so far back as 1785, found that a fraction of the supposed nitrogen of the air differed from the rest; and in 1895, one hundred and ten years later, Lord Rayleigh

and Prof. Ramsay read before the Royal Society their paper in which they described how they had isolated this constituent, and had studied its properties. The last three chapters of the book are devoted to a popular account of the discovery and properties of the new element (argon), and its position among the other elements. There should be a large public for a volume in which so many interesting phases of an interesting subject are described.

Star Atlas. By Winslow Upton, A.M. (Ginn & Co., Boston, U.S.A., and London. 1896.) We can commend this neat star atlas for the use of students of astronomy and the possessors of small telescopes. The entire sky is represented in six plates by the stereographic method of projection, showing all the stars visible to the naked eye with considerable clearness. The explanatory text contains a list of the constellations (accented, as a guide to pronunciation), the names of the stars most frequently designated by a special title, a list of magnitudes of some of the brighter stars, lists of the most interesting star-clusters and nebulæ, prominent coloured stars, variable and double stars, and some general directions for the use of the atlas. These tables and directions are quite of an elementary character, but are eminently suited to help and direct the beginner in astronomy or those with but small instrumental means. A set of key-maps are given to the plates. We wish—and this is the only criticism we have to make—that the traditional constellation figures and the strongly marked constellation boundaries had been placed in these key-maps rather than in the plates themselves. Their omission from the latter would have greatly increased their distinctness.

A Study of the Sky. By Herbert A. Howe, Professor of Astronomy, University of Denver. (London: Macmillan & Co. 1897.) 6s. Books on general astronomy are sufficiently numerous, and it might be thought that there was but little room for a new one, but Prof. Howe has succeeded in giving a distinctly original flavour to the work before us. This is partly owing to the occasional introduction of quaint simile or humorous quotation or remark. The feature, however, which most marks it off from ordinary books of the same class is the space devoted not to the "study of the sky," but to the study of the making of the ideal astronomer and of his instruments. This section is illustrated by a number of portraits (many of them exceedingly good) of the leading astronomers of the United States, and by representations not only of a finished telescope, but of an object-glass in its progress from the rough lump of glass to the finished lens. And that Mr. Howe is no mere "carpet" astronomer is abundantly evidenced by his chapter on "The Astronomer's Workshop," where he describes in detail the "mass of imperfections" which go to make up "the instrument which is to the eye a thing of beauty." In this country an astronomer is bound to devote himself and his work to the nation as a whole, rather than to that very small section of it which may evince a legitimate curiosity, and the observing hours in our National Observatory are held rigidly sacred from the intrusion of the sightseer or even the student. That such is not the case across the Atlantic, and how deeply the iron of it enters into the soul of the American astronomer, may be judged from Mr. Howe's quotation from one of the archives of an American observatory: "Visitors who come on working nights and interrupt a series of observations are undoubtedly parietosplanchnic Lamellibranchiates, afflicted severely with psittaceous psychopannychism." Chapters III. to VI. are occupied with a description of the constellations, and give both a diagram of their principal stars and a short history of the origin of the names of the groups and of the remarkable stars within them. "Conceit" is scarcely the term, however, to apply to the name "chariot" for the "Great Bear," seeing that it is by far the more ancient designation of the two. Neither is it called in England "*King* Charles' Wain," having no connection whatever with the monarchs either martyred or merry of that name, "Charles" being a corruption of "carl" or "churl," signifying a peasant. The chapters on the sun, moon, and planets are extremely lucid. Mr. Howe is very much up-to-date in giving a drawing illustrative of the "markings on Venus." The printing and illustrations are, on the whole, very good. We remark, however, on page 177, the word "know-ledge" divided as "knowl-edge."

SHORT NOTICES.

Light as the Interpretation of the Law of Gravity. By Alexander M. Cameron. (Angus & Robertson, Sydney.) Mr. Cameron is apparently one of those original thinkers who have ideas but find it difficult to obtain a hearing. The subject-matter of this little book was originally submitted to the Royal Society of New South Wales, and the Council rejected it as unsuitable for the purposes of the Society. The author, therefore, "in humble and respectful deference to all men—lovers of science, upholders of truth, abhorers of humbug"—sends out his theory to the world at large. He has ascertained that Newton, and the goodly number of other great scientific men who have contributed to our knowledge of the planet on which we live, are all wrong! To remedy this state of things, Mr. Cameron presents us with a new cosmogony all his own, in which, among other interesting news, he tells us that "comets of more than one tail evidence a once planet system with as many satellites as there are tails."

The Story of the Chemical Elements. By M. M. Pattison Muir. (Newnes.) 1s. On first opening this book two pictures attracted our attention—the one illustrating alchemical operations, which reminds us of the time when men studied chemistry almost entirely with the object of finding the so-called *philosopher's stone* and the *elixir of life*; and the other showing a modern chemical laboratory such as the latter-day chemists use, and in which they have done so much, in an indirect way, towards realizing the ideal of the misguided devotees of the *black art*. Prof. Muir tells an enthralling story of the wonderful transformations of matter under the chemist's magic wand. Ignoring formulæ, he appeals in homely phrase to the imagination of the reader.

The Story of the Weather. By G. F. Chambers. (Newnes.) 1s. At the present time, when cricket and lawn-tennis are coming in for their turn among English pastimes, a reliable weather prophet would be handy. It would appear from this little book that the lower animals are "cognizant of approaching changes in the state of the air long before we know of their coming by other signs." When asses bray more frequently than usual, when pigs are restless, and so on, rain, wind, and bad weather generally may be expected. In short, Mr. Chambers has not only indicated to us the modes of scientific forecasting of the weather, but he has also brought together all sorts of old-time notions which are certainly interesting and no doubt useful.

Fruit Culture for Amateurs. By S. T. Wright. (Upcott Gill.) 3s. 6d. It is a well-known fact that many amateurs grow fruit of various kinds that would do credit even to the professional gardener, but the amateur in general falls far short of this high level. Mr. Wright, in order to assist those who wish to cultivate fruit, both under glass and in the open, has here indicated what to grow under given conditions and how to grow it. In Section I., apples, pears, plums, apricots, cherries, etc., are dealt with as fruits for outdoor culture; and in Section II., grapes, peaches, figs, melons, etc., for culture under glass. Section III. contains instructions for grafting, budding, storing, packing, manuring, etc.; and in an appendix the methods of attacking insects and other foes which the gardener has to contend with are described. The volume is beautifully illustrated throughout.

The History of Mankind. By F. Ratzel. (Macmillan.) Monthly Parts. 1s. each. Already seventeen parts of this work have appeared, and it will conclude with the thirtieth. The aim of the writer is to give the broadest possible view of humanity as a whole, acquainting us not only with what man is, but with the means by which he has become what he is; hence, all nationalities, civilized and uncivilized, are included. An effort has been made to assign to the proper place in the species any given race which is not always determined by the difference of civilization between any two groups, for this may bear no kind of relation to the difference of their endowments. A coloured frontispiece accompanies each part, the

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subjects covering a wide range, to wit—an Australian family party; a farm in the Philippines; Polynesian weapons and costume, etc., etc.; and hundreds of illustrations, depicting all phases of human life, adorn the text.

Röntgen Rays. By Edward P. Thompson. (D. van Nostrand, New York.) 7s. 6d. We have here a most exhaustive summary of the practical applications of the so-called X rays, together with the facts and principles relating to the phenomena occurring between and around charged electrodes separated by different gaseous media at various pressures. A valuable feature of the work consists in the numbering of the paragraphs which contain cross-references to other parts of the book where kindred phenomena are described, thus facilitating analogy, contrast, and suggestiveness. A fine portrait of Dr. Röntgen forms the frontispiece, and there are sixty diagrams and forty-five half-tone illustrations in the text, all of the best. A chapter on "Theoretical Considerations" is contributed by Prof. Anthony. The large number of references to periodical literature greatly enhance the value of Mr. Thompson's book.

Exterior and Interior Photography. By F. W. Mills, F.R.M.S. Those who have mastered the preliminaries of photography—have, in fact, soared above the snap-shot stage—will find this little book very useful. It deals with the science of the effects of light on the plate and on the eye, and the manipulation of the camera in taking artistic portraits or interiors. It teaches how to finish a photograph, and many useful hints and reliable formulæ are given.

Everybody's Guide to Photography. By "Operator." This is a thoroughly up-to-date and practical little book. It is very comprehensive, including even an explanation of the nature of the X rays, and should be found of great service to a practical photographer. The miscellaneous information given is decidedly above the average of photographic guide books, and a great number of pitfalls to which the amateur is inclined to fall an easy prey are shown up, and may be avoided by a careful perusal of this guide.

Celestial Motions: a Handy Book on Astronomy. Ninth Edition. *Remarkable Comets.* Fifth Edition. *Remarkable Eclipses.* Second Edition. By W. T. Lynn, B.A., F.R.A.S. We have pleasure in noting new editions, carefully revised and brought up to date, of the three handy little reference books with which Mr. Lynn's name is so intimately associated. Mr. Lynn's well-known care and exactness, combined with a clear and concise style, fully account for the popularity evidenced in the case of the "Celestial Motions" by the appearance of nine editions in less than fourteen years.

Mr. Henry Frowde announces that a work of considerable interest to practical astronomers is in the press, viz.: "Tables for Facilitating the Computation of Star-Constants." By E. J. Stone, M.A., F.R.S., formerly Her Majesty's Astronomer at the Cape of Good Hope, and, later, Radcliffe Observer at Oxford. Modified and Revised by H. H. Turner, M.A., B.Sc., Savilian Professor of Astronomy in the University of Oxford.—Mr. Turner claims that his revision will effect an appreciable saving of time.

BOOKS RECEIVED.

Birds of our Islands. By F. A. Fulcher. (Melrose.) Illustrated. 3s. 6d.

A Treatise on Rocks, Rock-weathering, and Soils. By George P. Merrill. (Macmillan.) Illustrated. 17s. net.

The Story of the Mine. By Charles Howard Shinn. (Gay & Bird.) Illustrated. 6s.

A Recalculation of the Atomic Weights. By Frank Wigglesworth Clarke. (Smithsonian Institute, Washington.)

City and Guilds of London Institute. Report of the Governors, March, 1897.

Report of the Directors of the Liverpool Observatory, 1896.

Is the Earth a Planet? By C. Robertson. (Elliot Stock.) 2s.

First Stage Physiography. By A. M. Davies, B.Sc. (Clive.) Illustrated. 2s.

Genesis and Matrix of the Diamond. By the late Henry Carvill Lewis, M.A. Edited by Prof. Bonney, LL.D., F.R.S., from Unpublished Manuscripts. (Longmans.) Illustrated. 7s. 6d.

The Naturalist's Directory, 1897. (L. Upcott Gill.) 1s.

The Story of the Earth's Atmosphere. By Douglas Archibald, M.A. (Newnes.) Illustrated. 1s.

A Handbook of the Birds of Great Britain. Naturalist's Library. Edited by R. Bowdler Sharp. (Allen & Co.) Illustrated. 6s.

Problems of Nature. By Gustav Jaegar, M.D. Translated and Edited by Dr. Schlichter. (Williams & Norgate.)

Wild Norway. By Abel Chapman. (Arnold.) Illustrated. 16s.

English Literature. By Stopford A. Brooke, M.A. Literature Primers. (Macmillan & Co.)

The Months. By Leigh Hunt. With Biographical Introduction by William Andrews, F.R.H.S. (London: Andrews & Co.) 2s.

Fortnightly Review—May. (Chapman & Hall.) 2s. 6d.

The Elements of Physics. By E. L. Nicholls and W. S. Franklin. Vol. III.—Light and Sound. (Macmillan.) Illustrated. 6s. net.

Results of Rain, River, and Evaporation Observations. With Maps and Diagrams. By H. C. Russell, F.R.S., Government Observatory, New South Wales.

The Vertebrate Skeleton. By Sidney H. Reynolds, M.A. (University Press.) Illustrated. 12s. 6d.

First Stage Mechanics of Fluids. By G. H. Bryan, D.Sc., and F. Rosenberg, M.A. (Clive.) Illustrated. 2s.

The Year Book of Photography and Amateurs' Guide, 1897. (*Photographic News* Office.) Illustrated. 1s. net.

The Birds of our Country. By H. E. Stewart, B.A. (Digby, Long, & Co.) Illustrated. 3s. 6d.

Heart Disease and the Nauheim Treatment. By Joseph Kidd, M.D. (Hodder & Stoughton.) 1s.

Beetle Collectors' Handbook. By Dr. E. Hofmann. (Sonnenschein.) Coloured Plates. 4s. 6d.

ARISTARCHUS AND THE SINUS IRIDUM.

By E. WALTER MAUNDER, F.R.A.S.

TWO great observatories are at the present time engaged in the work of publishing photographic atlases of the moon. Such a publication has been mooted from the very earliest days of astronomical photography, but its actual accomplishment has for years past seemed in danger of indefinite postponement. It is therefore cause for especial congratulation that not one such atlas, but two, are already in progress of publication, whilst a third is promised.

The first atlas is being produced from the negatives secured by MM. Loewy and Puiseux with the great equatorial coudé of the Paris Observatory. The original negatives were some six and a half inches in diameter, and have been subsequently enlarged in the camera fourteen or fifteen times, and have been reproduced in heliogravure by M. Fillon. They are therefore on the superb scale of about eight feet to the lunar diameter. The quality of the reproductions is of the highest order, and being in heliogravure they are permanent, and only less faithful than would be positives on glass. The character of the pictures is one of vivid contrast and bold relief.

The second atlas comes from the Lick Observatory, and consists of enlargements from negatives of the moon taken in the focal plane of the great thirty-six-inch refractor of that observatory, but with the aperture considerably reduced. The atlas is being prepared and published at the cost of Mr. W. W. Law, of New York City, and is intended when complete to consist of at least sixty plates with index map. The scale of reproduction is considerably smaller than that of the Paris atlas—the magnification being only about seven diameters. The resulting chart is to be on the same scale as the classic maps of Beer and Mädler—38·36 inches to the lunar diameter. The chief object of the reproduction has been to bring out detail rather than to exhibit contrast. The Lick photographs are therefore less striking as pictures than those of the Paris atlas, but possess some advantage over it. The two will be largely supplemental of each other, and together will supply a record of the lunar surface far surpassing in accuracy and value anything which we have hitherto possessed.

The accompanying plate is a reproduction, on a reduced scale (two feet to the lunar diameter—that is to say, on the same scale as is represented in the maps of Neison's moon), of the fifth photograph in the Lick series. The reduction was necessary in order to get the entire picture into the page of KNOWLEDGE, but has rendered unavoidable some loss of distinctness of detail. It repre-

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owledge.

SOUTH.

WEST. EAST.

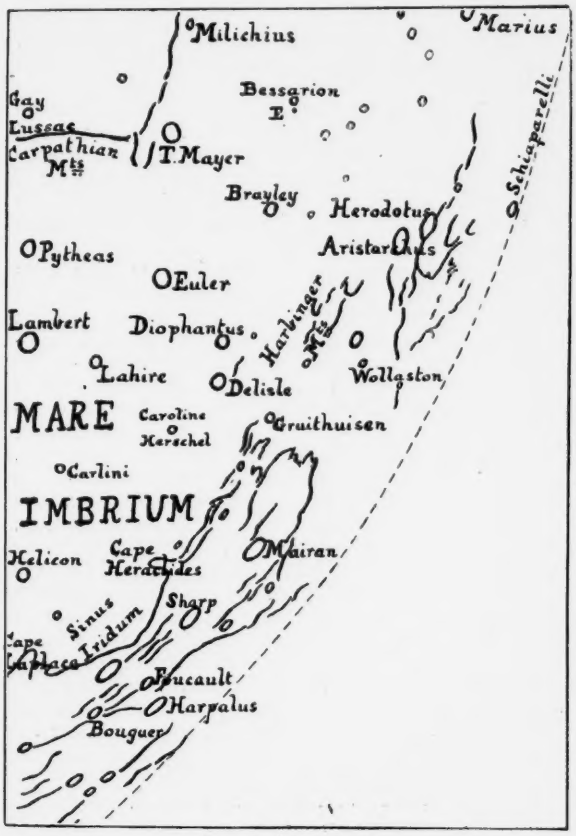
NORTH.

ARISTARCHUS AND THE SINUS IRIDUM.

Greenwich Mean Time, with the 36-inch Refractor of the

sents the eastern margin of the great Mare Imbrium as photographed on October 18th, 1896, at 18 hrs. 32 min. 41–47 secs., Greenwich mean time, 2 days 10 hours before the full.

Some of the photographs taken at Mount Hamilton by Profs. Holden and Colton have been sent to Prof. Weinek



Key-Map to Plate of Aristarchus and Sinus Iridum.

at the observatory at Prague, who enlarges them to a scale fully three times as great as that of the Lick atlas, and proposes to issue them in sheets of about nine and a half inches by eleven and a half, as an atlas on the ten-foot scale. Such a magnification is, however, the very outside of that which the negatives will fairly bear—if, indeed, it does not err on the side of excess. Nothing is gained by enlarging a negative to such an extent as to bring into evidence the granulation of the plate, and to render it necessary to hold the picture at much beyond the ordinary visual distance in order to get rid of this disturbing effect. Probably the Lick scale, beside having the advantage of corresponding to a standard map, is in itself more judicious than Prof. Weinek's or that of the Paris atlas.

The two most striking features of the section of the moon given in our plate, are the brilliant region of Aristarchus and the magnificent bay of the Sinus Iridum, with the noble Highlands which embrace it.

Aristarchus, as is well known even to the merest tyro in selenography, is the brightest object on the surface of the moon. So bright is it that it is sometimes seen shining like a star, even when the surrounding region is illuminated only by earth light when the moon is young. Or from time to time—as happened to Captain Noble on August 15th, 1883—the moon may be absolutely blotted out to the observer by mist or passing cloud, and yet this remarkable formation continues to "shine like a small ill-defined planet."

The formation is not a large one, as it is a ring-plain of only twenty-nine miles in diameter, and its wall rises but some two thousand feet above the surrounding surface. The interior is deep—how deep it is difficult to say, the measures of different observers being by no means accordant; but it would appear to be some three or four thousand feet below the level of the outer surface. The central mountain is of quite insignificant height, but forms the most brilliant point of all this bright region—the floor being only slightly less bright, and the north and east wall coming next in the order of brilliancy.

The extreme brightness of this object renders the study of its details a matter of some difficulty, and, as will be seen in the photograph, it is decidedly over-exposed. The very remarkable terracing and series of buttresses which it possesses, particularly towards the south, escape notice on the photograph, partly from this reason, and partly from the character of the illumination at the time the photograph was taken. But another remarkable feature is quite obvious—that is to say, the great system of rays or bright streaks, which radiate from Aristarchus as they do from Tycho to a very much greater extent. Still, Aristarchus may claim to be one of the seven great ray centres, though far from being the chief. Two others, Copernicus and Kepler, lie just outside our plate to the south, and their rays may be noted as entering our photograph, and, in some instances, becoming confused with the Aristarchus rays. Euler, a minor ray centre, is included in the plate.

Herodotus, the companion of Aristarchus, is far less bright; the floor, in particular, being very dusky. The most interesting feature of the formation, the great serpentine cleft, is admirably shown on our photograph, especially the point where it turns south, and defines the eastern boundary of the high plateau of Aristarchus. This latter region is one of great complexity, and still offers a wide field for the close student of selenographic detail.

Turning northward from this interesting region, which we might almost call the lunar "Albion," and passing the pretty little group of the Harbinger Mountains—which do not, however, possess any features sufficiently striking to detain us now—we reach the small ring-plain, Gruithuisen. One of the dependencies of this latter is a high, flat, isolated plateau (well seen on the photograph), which forms the introduction to the noble Iris Highlands, the wild and lofty character of which the plate distinctly indicates. These Highlands form a portion of that great mountain region which runs right round the north of the moon, bordering the two great seas of Serenity and of Rains, until it ends in Mount Argæus. Of this great mountain system the Iris Highlands form the loftiest and most intricate region, and, in particular, between Mairan and Sharp we find its wildest portions, the highest peaks of which rival the giants of the terrestrial Alps or Caucasus.

The great feature of these highlands is the magnificent bay which they so nearly enclose, and from which they take their name. The Sinus Iridum is some hundred and thirty-five miles across, between the two horns of the bow, and the sagitta is eighty-four miles. The area, therefore, of the bay is double that of Wales, including Monmouthshire. The splendid sweep of the cliffs—almost a true semicircle, and rising in certain peaks to the height of Mont Blanc—stand out in such contrast to the dark level surface of the Sinus that it seems impossible to escape the suggestion that we have here a veritable coast-line,

whatever may have been the composition of the ocean which once washed it, or however that ocean may have disappeared.

Of the two great headlands which form the horns of the bow, the more westerly, Cape Laplace, is considerably the higher, reaching as it does an elevation of nine thousand feet. Cape Heraclides, the more easterly, is also a bold headland, but not quite half the height of its companion sentinel. The profile of the cape and the adjacent details have received a good deal of attention, not only on account of their really striking appearance, but also from their fancied resemblance to a female figure—Cape Heraclides being the "Moon Maiden."

The region of our chart is one which opens to us not a few perplexing questions. First of all, whence comes the astonishing brilliancy of Aristarchus? Were the whole moon of the same brightness, one might accept with but little question the ingenious theory which Mr. S. E. Peal has urged with such fertility of argument and persistency of endeavour. But the average albedo of the lunar surface falls so far below that of snow, its brightness per unit of surface is so distinctly less than that of the poles of Mars, that it appears impossible to accept Mr. Peal's representation of the moon as a world which has donned the white garb of a universal and eternal winter.

Aristarchus, indeed, might from its brightness lay some claim to be considered a snow-capped mountain, but it possesses absolutely no features of height and position which should make it a more favourable object for snow deposit than its near neighbour Herodotus. Its walls are by no means specially lofty, nor is it situated near the poles, its latitude being only twenty-three degrees. If we take account of the suggestion that has been made, that the dark tones of the *maria* are due to the deposit formed by the age-long accumulation of meteoric dust, then, again, Aristarchus presents us with a riddle, for it is well towards the eastern side of the moon, which will naturally receive the greatest supply of meteoric fragments, and should, therefore, be darker than similar formations further to the west. The suggestion, however, assumes—I think, without warrant—that meteorites falling on the moon would be as dark (that is, have as dull a surface) as those which reach the ground here. The slag-covered meteorites with which we are familiar here have passed through our dense atmosphere, and been subjected to an intensity of frictional heat altogether unlike anything which their brethren encounter ere they strike the lunar soil.

There is another suggestion which must account, to some extent, for the varieties of tint and brightness of the moon's surface. This we may briefly express by the term "weathering," for lunar weathering there must be, though of a very different kind from terrestrial. The alternation of exposure for fourteen days to the direct rays of the sun, with the exposure for a similar period to the cold of space, must set up a continual disintegration of the surface, and the particles thus separated will, as Mr. Davison has pointed out (KNOWLEDGE, Vol. XIX., p. 278), tend to "creep" downwards in all cases where they are resting on a slope. We may look upon it, then, that the greater brightness of the mountains than of the grey plains is due partly to the fact that the surface of the former consists largely of material pretty recently exposed—a point to which Mr. Peal has drawn attention (*Journal of the British Astronomical Association*, Vol. VII., p. 7); but this theory does not help us with Aristarchus, where we find the floor as bright as the central peak or the rampart.

We are forced, I think, then, to suppose that Aristarchus owes its brilliancy partly to the actual materials of which it is composed, and partly to its being of such recent formation that weathering has not yet produced any visible deposit upon the floor.

It may be worth while in this connection to draw attention to one of the minor markings of our plate. Nearly in the centre of that portion of the Oceanus Procellarum which comes within our photograph is a bright spot which marks the place of the little ring-plain, Bessarion. The northern part of the spot shows us a very distinct crater, Bessarion E, surrounded by a bright, glittering surface—a type of formation specially classified by Mädler as "light-surrounded craters," and distinguishing the region of the moon near this meridian, and for some degrees on both sides of the equator. If we may extend the analogy of the conclusion which we have already reached in the case of Aristarchus, these, too, may be of recent origin, and their neighbourhood to Aristarchus may be an indication that we have here the region of the moon latest subject to violent change.

The Sinus Iridum leads us to reflections of a very different character. Noting the frequency along the borders of some of the "seas" of walled plains and ring-plains which have been attacked or broken down on their seaward side—such as Fracastorius, Julius Cæsar, and many others—some observers have suggested that the Sinus Iridum is but a larger instance of the same character. Were its circle complete it would about equal Clavius, Schickard, or Grimaldi, so that its dimensions would not be excessive. It would then bear to the Mare Imbrium much the same relation that Fracastorius does to the Mare Nectaris. An examination, however, of the highlands that bound it, scarcely, I think, supports this view. They do not appear to form part of a once circular wall, the half of which is now lost; nor is it quite conceivable that a rampart of such magnificence as the other semicircle must have been in order to correspond, could have sunk into the Mare Imbrium and left no sign. It seems far more reasonable to suppose that in the Iris Highlands, and in the bold contour of the Sinus Iridum, we have preserved to us features of the primeval structure of the lunar surface.

DAY VIEWS OF VENUS.

By P. M. RYVES.

FEW people know how easy it is to see Venus in the day with the naked eye. It has been said that Venus is visible in daylight once in eight years only, but I can affirm, from my own observations, that this supposition is an incorrect one.

Observations of Venus in the daytime were made at a very early date. The following are a few instances:—A.D. 398, 984, 1008, 1014, 1077, 1280, 1360, 1715, and 1750.

Arago relates that General Buonaparte, upon repairing to Luxemburg, when the Directory were about to give him a *fête*, was "very much surprised to find the crowd assembled in the Rue de Touracour pay more attention to a region of the heavens situated above the palace than to his person or the brilliant staff that accompanied him. He inquired the cause, and learned that these curious persons were observing with astonishment, although it was noon, a star, which they supposed to be that of the conqueror of Italy—an allusion to which the illustrious general did not seem indifferent when he himself, with his piercing eyes, remarked the radiant body." The star in question was no other than Venus.

At the beginning of March Venus was in a very favourable position for observation, and was distinctly visible in the day.

On June 3rd she will again be at greatest brilliancy, so that she will be favourably situated for day views most of June.

Being now a little south of the sun, we know that if we mark a place from which the sun will be just hidden by a chimney or gable at noon, Venus will be a certain distance below that point at a certain time before the sun; or we may mark a place from which the sun appears the right distance above the object we have chosen, and Venus will be just over it.

This table will show how much to allow for different dates:—

	Venus South of Sun.	Venus Souths.
		h. m.
June 4th ...	11°⅛ ...	9 18
,, 11th ...	11°¼ ...	9 7
,, 18th ...	10°½ ...	8 59
,, 25th ...	9° ...	8 54

If we fail to find her by this method, we can get up before the sun and keep her in sight all day, by continually making fresh marks.

When we have once seen her we can make a mark from which she will appear exactly above the chimney, and we shall have no difficulty in seeing her again.

If such a method be adopted we can easily find her without any optical aid; indeed, I have found her when out in a field where I scarcely knew my bearings, on a hazy day, without any protection from the light of the sun.

As it is always an advantage to be shaded from the sun, the south-west side of a house is a good place from which to observe. We may also observe from the open window of a room, keeping as far back into the room as the altitude of Venus will allow, as this shields us not only from the light of the sun, but the brightness of the sky, which would otherwise be glaring us.

For the same reason Venus is seen very distinctly when the sun is obscured by a large cloud.

If, in addition to the sun's being hidden by a cloud, the sky be of that brilliant clearness generally prevalent in windy, showery weather, then sometimes—even if it be mid-day—Venus will be seen almost to sparkle, and it is impossible to glance in her direction without seeing her.

The following are some of my notes:—

March 1st, 1897.—Saw Venus at 2 P.M., the sun being obscured by a cloud, and kept her in view till dark. Made some telescopic observations in the evening.

March 2nd.—Saw Venus at 2.15 P.M.

March 3rd.—Saw Venus at 2.30 P.M.

March 6th.—Saw Venus at 1.30 P.M. Sky hazy, sun shining.

March 10th.—Saw Venus at 11.45. I could see her quite distinctly through glass.

March 12th.—Saw Venus at 11.30.

March 13th.—Saw Venus at 10.40.

March 17th.—Saw Venus at 3.5 P.M.

March 18th.—Saw Venus at 11.40.

Owing to the weather having been unfavourable since the last date, I have only been able to obtain glimpses.

THE SWIFT'S NIGHT-FLIGHT.

By CHARLES A. WITCHELL.

DURING June and July, dwellers in places where the swift abounds may investigate its recently discovered habit of soaring upward at evening and (apparently) spending the night in the sky. This interesting incident may be observed in June more easily than in July, because the evening sky is clearer in the former month than in the latter. It was just ten years ago that observers in England first noticed this extraordinary behaviour on the part of a diurnal British bird; and during that cloudless Jubilee June three persons were watching, night after night, the soaring swifts.

One of these observers was Mr. Aubrey Edwards, son of the vicar of Orleton, R.S.O., Herefordshire, who often saw the swifts from Orleton Church depart upward at night; and he, with his father and brother, remained in the churchyard until 10.30, or even 11 o'clock, watching for the birds, which did not return. There were about forty of these ascending swifts, which Mr. Edwards justifiably conceived to be males; and other swifts remained in the nests.*

In the same month Mr. Douglas Brodie, of Croydon, was making similar observations on the colony of swifts which lived under the eaves of the houses in the centre of that town—as appears from his reply to a query of the writer at a later date. "A certain number of the colony, after the rest have gone to roost, go soaring up in circles with a peculiar quivering of the wings, till they go clean out of sight. With field-glasses I have seen them nearly a minute longer."†

On the 10th June, 1887, the writer was watching a large flock of swifts from a garden halfway up Stroud Hill, in Gloucestershire. The air was very clear, and the swifts whirled across and across the sky. The sun had set, but the birds did not descend. They finally went right up out of sight. On the 21st the swifts at Stroud exhibited the same wonderful behaviour, which was recorded.‡

Since then I have every year watched for the upward night-flight of the swifts; but as the flights occurred at a rather inconvenient time for observation, there were often several successive evenings on which nothing of the kind was seen. Often, also, the birds would fly away towards the horizon, though when they did this late in the evening their course was generally an upward one. They were, however, no less inclined to a lofty flight on a cloudy night than on a clear one; and I often saw them vanish into the clouds. But this never happened when the air was very thundery.

It is convenient to watch the swifts from a somewhat elevated spot, so that they may be kept within view as continuously as possible, since, if they pass out of the field of vision at a distance, it is almost impossible to find them again. It is also desirable to have a support to lean upon, for without this the constant gazing towards the zenith becomes very tiring, especially if field-glasses are used. It is not often that the birds can be seen during the whole of the upward flight; they generally swing around in wide circles for some time, and pass out of sight towards the horizon, after which the repeated cry, *swee ree*, first indicates their return. The whole incident, as it generally occurred, may be described as follows:—

The sun has set, and most of the small birds have retired for the night, though the sparrows are still noisy in the creepers on the house. Most of the swifts are flying low over the meadows, but some are in the sky; and of these a few are chasing others, and performing those magnificent swoops by which it appears that the males drive the females to their nests. Certain it is that the pursuing birds (always acting singly) chase particular individuals, whose course they follow at a greater altitude, but always

* *Nature*, 27th October, 1887. † *The Field*, 18th May, 1889.
‡ *The Field*, No. 1851.

with the intention of finally descending in a falcon-like stoop at the lower bird, who, anticipating the attack, swerves downward, and finally plunges headlong. The swishing sound produced by the descending swifts can be heard at a considerable distance. The pursuer mounts again, almost vertically, and renews the assault. This goes on for some time, and when it ceases many of the swifts have already retired to the nests. The others begin to pursue each other in noisy groups, at about the level of the housetops, and this game is kept up for a quarter of an hour or longer, the birds traversing a wide area, and being sometimes out of sight for several minutes. Then they continue the same sport at a higher level, no longer descending so low as the roofs.

At about forty minutes after sunset (whether in June or July) the group of swifts begins to whirl round and round like a mob of rooks; but again and again the cluster breaks up in a pursuit and a mad noisy rush across the sky. Yet the birds are gradually attaining a higher position, and their screaming becomes the less noticeable. Their wings have often a tremulous motion, reminding one of the flight of an ascending skylark. Still, there is no deliberate upward flight—only a succession of swoops and rushes terminating at increasing distances from the ground. The birds keep fairly together, and not one descends to the houses; but it may be that the cluster is joined by another group, coming you know not whence. Dusk is beginning to fall, and even the sparrows are silent; but the cries of the swifts can yet be faintly heard. The birds may now be easily lost sight of altogether, especially if there be no white fleecy clouds high overhead to throw into relief the whirling black dots in the sky. Now is the time to use a field-glass or a small telescope, and, having once found the birds with it, to keep them within the field as long as possible. The peculiar skylark-like motion of the wings is now almost continuously maintained, and the birds, instead of whirling round in a cluster, seem to prefer to lie head to wind. Against the loftiest white clouds their movements may yet be clearly traced: up and up they go, appearing smaller each moment, till even the power of the glass is overcome, and the tiny specks vanish for the night.

As you drop your arms wearily you find that the dusk has fallen, the bats are out, and the evening mists are rising; but the swifts must now be nearly on a level with those remote flecks of cloud, which, at an immense height, are yet snowy in the sunshine.

This charming incident of bird life cannot be observed from all towns and villages with equal certainty. At Stroud I used to see it often, but in my present neighbourhood swifts are not very plentiful, and only one or two have been seen to go up at nightfall.

THE LANGUAGE OF SHAKESPEARE'S GREENWOOD.—I.

By GEORGE MORLEY, *Author of "Leafy Warwickshire," "In Rustic Livery," "Sweet Audrey," etc.*

THOUGH something less than two and a half hours' journey from London to the fringe of the famed Forest of Arden, in "leafy Warwickshire," it is little short of surprising that, at the end of the nineteenth century, the same forms of speech in vogue in the days of Shakespeare, and even before then, should still be in use in every part of the county in all their quaintness, directness, and simplicity.

It *is* surprising, but I also think it is extremely pleasant; for civilization, utterly offended, as it appeared to be, with the picturesque forms of speech, migrating from the pastoral plains to the hothouses of society, invented a language of its own—a catch-word or slang language—which, however "smart" and applicable it may be in the mouths of those who are pleased to use it, cannot compare in grip, in appositeness, or in poetical feeling with the strong, broad, euphonious, and clearly expressed provincialisms—centuries old as they are, but still in vogue, with an unslayable uniformity of meaning and utterance; and in Warwickshire (owing, perhaps, to the high place which it holds in the best of English literature, through the genius of its literary sons and daughters) it *is* pleasant to know that the old forms of speech, so valued and so intrinsically valuable as the original expression of an ancient and historical people, are, perhaps, as deeply rooted to-day as they were in primeval days.

Why it is so I cannot say. "Leafy Warwickshire" was an impenetrable forest. But, though still leafy—though still, with regard to some of its villages and hamlets at least, perfectly isolated from the world of fashionable language—it is far from being impenetrable to-day. The railways of the nineteenth century, following in the footsteps of the mediæval constable of the shire, have cut their way in a network of lines right through the heart of "the heart of England." Moreover, from the most isolated of the villages the carrier comes almost daily into the fashionable places of modern civilization.

As an illustration of the inability of country-born folk in Warwickshire to cast off the yoke of their natural language, even though their contact with town life is busy, daily, and continuous, I may instance the case of the Harbury carrier.

Now, Harbury is a village but six miles south-east of the fashionable town of Leamington, where there are so many scholastic institutions, all racing towards a perfect erudition in everything, that language ought to be in an extremely forward state in that "seat of learning," as Leamington has been called.

As I am anxious to make this paper as interesting as I can, in the hope that it may serve as a contribution to the rural dialect of this charming county which has already been garnered up—in the plays of Shakespeare, the novels of George Eliot, and the archives of dialect societies—I shall give the language of the peasants of Warwickshire as I have heard it spoken by them during the past five or six years, in villages near my home at Leamington: premising that in this form—catching the words as they fell from the lips of the rustics—greater value may attach to it; though the words will not necessarily run in the alphabetical order of the dictionary, my object being to write an interesting and chatty paper on some of the dialect words of the Warwickshire peasantry, rather than a learned, dry, analytical treatise on provincialisms.

The Harbury carrier comes into my "seat of learning" at least three times a week, and mingles with the townspeople; and yet from that man's speech he might well have been own brother to William, the lover of Audrey, resident in the Forest of Arden, in the days when the banished Duke held his court there under the greenwood tree.

"My ould man," he said—meaning his buxom wife, younger than himself, whom he sometimes brought with him in the cart—"hev med a blue biggen for the recklin' yander" (a young child was sitting in the conveyance). "'Tis a nesh 'un, ye see, an' canna goo in closen wi'outen summat's on yed when th' dag's fallin'."

A "biggen" is a dainty little cap worn upon the head of a small infant, to keep it from taking cold. In olden times the Warwickshire mothers took an especial pride in making these little "biggens," and some of them (one I have seen dating from the early years of the present century), with their frills, tucks, cords, and edgings, were perfect gems of the needlework art. In the Second Part of "King Henry the Fourth" (Act IV., Scene 4), Shakespeare alludes to them in the words:

"Whose brow with homely biggen bound,"

clearly indicating the fact that the "biggen" was a home-made article of head-dress provided for the "reckling" of the family, or a "nesh" child.

"In such bravery, too," is the pretty sentence you may often hear fall from the lips of a Warwickshire peasant woman standing beneath the honeysuckle of her own door. It refers to a girl's finery—her feathers, flowers, ribbons, and laces—and when, as is usually the case, its utterance is accompanied by a smile, it conveys the sweetest touch of encouragement with the faintest sound of reproach. This word, as applied to the small fineries of the toilet, was evidently in popular use in Shakespeare's days, for he uses it in "The Taming of the Shrew" (Act IV., Scene 3).

The "reckling," spoken of by the Harbury carrier, is, generally speaking, the youngest of the children; it is also applied to the weakest child, or the one longest in growing. This word—with the "g" always dropped, which is characteristic of Warwickshire rural dialect in all words ending with "ing"—is somewhat extensively used in sequestered villages. It is also spelt "wreckling," though the "w" is more frequently deleted, indicating probably that the child being small and puny is the "reck" or "wreck" of the family in a physical sense. In some villages nearer the towns a variant of this word is constantly heard. "Dilling" is used instead of "reckling," and has precisely the same significance.

"Dilling" is also applied indiscriminately to all small, long-growing, dwindling things. You cannot go into a farmyard or under the thatch of a cottage in Warwickshire without hearing this word. It is in the mouths of farmer, housewife, poultry maid, and child. Every small thing is a "dillin'." The smallest chicken in the brood is a dilling, so is the smallest duckling and gosling; and the dilling of the pig's litter is always the object of the housewife's especial care. There is luck in the pig's dilling. It is reared up with the bottle, kept in a stuff-lined basket near the kitchen fire, and as much attention paid to it as if it were the "dilling" of the human family.

A "nesh" child has a meaning almost identical with "reckling" and "dilling," though there is much more pathos in it. Anything, of whatever age, condition, or calling, that is weak, feeble, or ailing is a "nesh" thing. It is quite an usual thing to hear: "My poor gell's too *nesh* to goo slummockin' an' trapesin' over fields as if her war as frem as frem."

Now, in the Warwickshire rustic's mouth there is a word which, in direct opposition to "nesh," is often spoken with it. I have not noticed it in Shakespeare, but it is firmly rooted in the vocabulary of the peasant in all the little villages in Shakespeare's land; indeed, it was and is the joy of every Warwickshire village mother's heart to be able to call her offspring a "frem" child or "frem" children. To be "frem" is to be bonnie, lively, healthful, plump, and thriving; and as the bulk of village children are of this order, the word "frem" is in constant use.

"Frem" is also used with reference to the natural growths of the earth. Thus, luxuriant grass is "frem grass," well-growing crops are "fine an' frem." The waggoner will call his horse a "frem horse," the shepherd's calves and lambs are the "fremmest as he's ever 'ad," and the young collie is as "frem a dog as you'd find anywhere." In short, "frem" is the word for anything and everything that is strong, lusty, plump, thriving, and throbbing with health.

As a term of endearment, perhaps there is no word of dialect so old and yet so extensively used in the whole of Warwickshire as the word "wench," when applied to a young maid. Since Shakespeare used it in an affectionate sense in "The Taming of the Shrew" (Act V., Scene 2), and in the fifth act of "Othello," and again in "Romeo and Juliet" (Act II., Scene 4)—where Mercutio says, "Alas, poor Romeo! he is already dead! stabbed with a white wench's black eye"—the word "wench" has become as familiar in the pastoral mouth as the speaker's own tongue; and not only in the pastoral mouth either, for in the mouth of the urban dweller in Warwickshire "my dear wench" is a term constantly heard.

The word "wench" is also employed extensively in an endearing sense by those who have charge of cattle. A favourite cow, mare, ewe, or bitch is always a wench; a pat on the back, and "Eh! she be a good old wench," are sounds of the greatest familiarity in Warwickshire.

Then, as is often the case with dialect words, "wench" has a bad side to its character; it is sometimes used as a term of reproach. This is not very often, but when it is applied to a girl in this sense it seems to have an overwhelming weight of shame attached to it. I have seen a rustic maid cry bitterly at being called "a wench" in that peculiar tone of voice which implies a lightness and looseness of conduct quite inconsistent with the behaviour which should characterize a demure, decorous, and modest girl; while, on the other hand, I have seen the same girl smile radiantly when called "a wench" by her sweetheart or mother. It is, I suppose, all a matter of method; it is the way in which the word is uttered which seems to convey so much to those to whom it is applied.

In its reproachful sense the word "wench" means a bad, loose, vulgar, lewd, riotous woman or girl, who stands upon no ceremony, and has no respect for herself or for what her neighbours may think of her. It is thus allied to such peculiarly Warwickshire dialect words of opprobrium as "faggot," "doxy," "hussy," "slummock," and "salt." All these words are of venerable age, and are in constant use to-day in all the villages of the shire. "Doxy" has, perhaps, the worst signification. Shakespeare uses the word in "A Winter's Tale" (Act IV., Scene 2).

A "faggot" has not precisely the same meaning among Warwickshire rustics as "doxy," though it is somewhat akin in signification. It is a term which does not imply quite so much as "doxy," and yet sufficient to make the ears of a maid tingle who has any respect left for herself. A "faggot" literally means a careless, good-for-nothing, untidy person; and as the majority of Warwickshire girls and women are noted for their neat, thrifty, and careful manners and appearance, it may well be imagined how heartily they resent such a term of reproach as "faggot."

Any loosely attired, slatternly person—man, woman, or child—is a "slummock." You may not uncommonly hear a man say, "Donna thee look at me, mister; I be such a *slummock*. I hanna 'ad time to goo an' tidy mesen yet, like." A ragged colt is a "slummockin'" creature, so is a moulting fowl. Anything, in fine, which has not an air of trimness and neatness about it is a "slummock." It is a word which expresses much, and is very closely allied to that other reproachful word "moikin," which literally means a

scarecrow, but which is quite as often applied to persons who are negligent in their personal appearance as to the effigy which scares crows.

"If thee donna come in, ye hedgehog, I'll lace thee warmly." This is an expression I heard issuing from the mouth of a buxom woman with well-oiled and well-combed hair, who was standing at the door of a thatched cottage in the village of Offchurch. On a patch of green in front of the cottage an untidy boy, presumably her son, was idly stretched out playing with a young lurcher dog, and showing no disposition to obey the parental command. Now "hedgehog," as a term of reproach, has been in vogue in Warwickshire for a period of at least three hundred years. It is used by Shakespeare in "Richard the Third," when the ex-Queen Margaret, in cursing Richard, Duke of Gloster, calls him a "hedgehog." In rural Warwickshire the hedgehog is also known as an "urchin," and in former times (as is set down in many parish books in the immediate vicinity of Stratford-on-Avon) there were so many hedgehogs or urchins overrunning the land that sixpence a head was given for every one brought to the farmer or churchwardens—the latter entering the payments in their accounts.

This offer of reward brought both pleasure and profit to those concerned, and in it, I think, is to be traced the association which has given to boys, from Shakespeare's days to the present, the undesirable names of "hedgehog" and "urchin." Shakespeare alludes to the urchin in "Titus Andronicus" (Act II., Scene 3).

The "lace" mentioned in the above sentence has a peculiar meaning in the lingo of the Warwickshire peasant. It literally means to beat or thrash.

Talking one morning to the shepherd of the Combe Farm, about a mile and a half from my house at Leamington, he suddenly surprised me by saying, "Well, I mun shog on a bit. I were up at four, ye know, an' I can welly do wi' a shive o' summat to et an' a tot o' tay."

Here was a perfect professor of Warwickshire dialect: a veritable Shakespearean peasant in the art of the mother tongue! "Shog on a bit"? "A shive o' summat an' a tot o' tay"? Words which Shakespeare had used three centuries ago.

To "shog" is a word very much used at the present time by the peasants of this delightful county. Whether it is older than "jog" I cannot say, but as Shakespeare mentions "shog" in "Henry the Fifth" (Act II., Scene 3), we are entitled to regard it as a dialect word of some importance. It means to jog off, to make off, to move on slowly and easily, to shamble, to sidle.

A "shive" has also the garments of antiquity upon it, blended with the dress of modern days. If you go to-day into a Warwickshire hay or corn field when the labourers are having their lunch or dinner, the word "shive" will often salute the ear. "I mun hev a *shive* o' bread and bacon," says the driver of the cutting-machine, getting out his knife and opening it. A "shive" means a shave, a slice, a piece. Shakespeare caught the meaning of "shive" to a nicety in "Titus Andronicus" (Act II., Scene 1), where he says:—

> "What, man! more water glideth by the mill
> Than wots the miller of; and easy it is
> Of a cut loaf to steal a *shive*."

The word "tot" used by the Combe shepherd is a very prevalent word in all parts of rural Warwickshire. It means a cup, a mug, a saucerful, or a drop of tea or anything to drink. "Come thee in now, Biddy, lass, an' hev a *tot* o' cider," or "Hey, I be so dry like, I could just do wi' a *tot* o' drink," are expressions commonly heard in the fields and lanes. "Tot" has also a different signification when used in conjunction with "out" or "up." To "tot out" means to pour out. Again, "tot" is used in a slightly varied form, as "Come, butty, *tot up*," which means to drink up. The landlord, too, is often requested to "tot up" the score against a customer, meaning him to "add" it up to find out how much is owing.

The Warwickshire peasant is occasionally prone to use "t" and "th" instead of "d" in some of his words, with an effect at once peculiar and amusing. One day, in walking over the fields from Leamington to Lillington, I encountered a man who appeared travel-worn, and was the last person from whose mouth I should have expected to hear snatches of good dialect; and yet no sooner had I reached him than he said, without a word of introduction, "There usen to be a lather o'er the runnel yander when I wos a kiddie. Mother was nigh afraid to trusten me as fur as thisen, but I crossed the lather to t'other side as aim as aim."

A "lather" in the language of the rustic means a ladder, or little bridge with spars. This word is not very common, but is still used by the older inhabitants of the village. So far as I am aware, "lather" is a purely Warwickshire mode of expression. Some of the other words I have quoted are doubtless in vogue in Staffordshire and Leicestershire—at any rate, on the borders of those counties—but "lather," and other allied words where the "d" is dropped and the "t" sound substituted, is, I am disposed to think, a feature peculiar to and characteristic of the strictly Warwickshire dialect.

Though I have but touched the fringe of a delightful subject, I find that at this point I have written as much as I ought in the compass of one paper, and must conclude the subject in a further contribution. In the vocabulary of the Warwickshire rural dialect there are scores upon scores of curious words—many of them undoubtedly spoken by Shakespeare—which it would be a subject of the greatest interest to explain; but the few words I have dealt with will serve to bear out the saying which George Eliot placed in the mouth of Mr. Casson. They *are* "cur'ous talkers i' this country"; but it is the language which Shakespeare spoke and wrote, and, as the following quotation taken down from a woman's mouth will show, it is a language at once poetic, strong, and teeming with individuality of character:—

"I canna get a blench on the bonnie laddie's eye now, hardly—hardly a blench. 'Tis the way with 'em all when a dand faggot like Loo comes brevettin' about under their noses. Bless her, though—bless her! I canna 'elp sayin' on it. She's a sweet bit o' hussy, an' the darter o' my old schulemate Ju. The recklin' o' the bunch, too, an' the prettiest as Ju ever had. I munna be too hard on the laddie, I s'pose. Mothers mun goo a-one side when dand maids come tootin' about arter their sons. Eh! but my life's as holler as a deaf-nut wi'out that laddie's love. Hey, ho! so 'tis. Just as holler as a deaf-nut from Cuddington Wood."

MEASUREMENT OF THE EARTH.

By A. FOWLER, F.R.A.S.

THE town of Hammerfest, in Norway, has two chief claims to distinction. It is the most northerly town in the world (lat. 70° 40′ 11·3″ N.) and it possesses an astronomical monument of some importance. The latter is depicted in the accompanying photograph, and one can better imagine than describe the wonder with which it will be viewed by the Lapp fisher-folk who frequent the place, and even by many

of the good people of Hammerfest. The column and pedestal are of granite, and at the top is a bronze capital carrying a terrestrial globe of copper. Inscribed on the

The Meridian Column, Hammerfest. (From a Photograph by W. Shackleton.)

column, in Latin and Norwegian, is the following legend:—"*The northern termination of the arc of meridian of 25° 20′ from the Arctic Ocean to the River Danube, through Norway, Sweden, and Russia, which, according to the orders of His Majesty King Oscar I., and the Emperors Alexander I. and Nicholas I., and by uninterrupted labours from 1816 to 1852, was measured by the geometers of the three nations.*"

The aim of the monument is therefore to commemorate the completion of a gigantic piece of surveying, having for its primary object the measurement of the earth, and to provide a permanent mark in order that the measurements may be repeated at any future time if considered desirable. No longer arc of meridian has yet been measured, and it may not be without interest to recall some of the facts connected with this great undertaking, culled mainly from the monumental report which was drawn up by its chief organizer, the celebrated F. G. W. Struve.*

First, however, a few words as to the general principles involved in the operations of *geodesy*, or earth measurement.

When once the idea of a globular earth was accepted, the determination of its dimensions became theoretically a very simple matter, involving only the measurement of the length of a portion of a great circle, the number of degrees in which could also be ascertained. One of the arcs which can be most readily measured in degrees is one which forms part of a great circle passing through the Poles, for the reason that the measurements of the difference of latitudes of the terminal points furnishes the requisite angular value. In this way the measurement of the earth is usually carried on by measuring so-called *arcs of meridian*, from which the length of a degree, and therefore the circumference and diameter of the earth, at once become known. If the earth were really spherical, the measurement of even a single degree would suffice for the determination of its dimensions; but, as degrees are found to be of different lengths, it becomes necessary to measure a great number of them, in various parts of the world, in order that the precise size and shape may be investigated by analytical geometry.

Two distinct operations are requisite. The first has for its object the accurate measurement, in linear measure, of the length of the meridional arc; the second the astronomical determination of its angular value on the globe.

The first of these operations depends primarily upon the measurement of a base line, some miles in length, upon the most level stretch of land available. The laying down of a base line is a most tedious and delicate process, for even if it be seven or eight miles long, it must be as straight as possible, and its length must be ascertained almost to the nearest inch. One of the greatest difficulties to be faced is the fluctuation in the length of the measuring rods, consequent upon changes of atmospheric temperature, but this has been ingeniously overcome by the use of the compensating bars invented by Lieut. Colby. A bar of brass is firmly joined at its centre to one of iron, and pivoted at the ends are a pair of projecting metal "tongues," certain marks on which remain at a constant distance, because the expansion of one rod pushes them apart just as much as that of the other endeavours to bring them nearer together. Such rods cannot be put in contact end to end, and they are accordingly placed a constant and known distance apart by means of a pair of microscopes, which are joined together by compensation bars. Sights and levels to ensure the straightness of the line complete the essential parts of the apparatus.

The base line having been laid down, very accurate theodolites are placed at its extreme ends, and a distant object which can be seen with both instruments is selected for observation. At each end the angle between the base line and the object is measured, and the distance of the object from either end then follows from a simple trigonometrical calculation. The sides of such a triangle may now serve the same purpose as the original base line, and other objects, which are often specially erected signals, are similarly sighted and their distances measured.

By this system of *triangulation*, the measurement is carried on to any desired extent, being checked here and there by the actual laying down of new base lines, the lengths of which have been previously determined in the course of the trigonometrical surveys. The general disposition of successive triangles will be gathered from the accompanying map, representing the actual triangles measured near the southern end of the great Russian arc. From the calculated dimensions of the individual triangles, the distance between the extreme ends of the arc can readily be deduced.

For the determinations of latitude of the extreme or intermediate points, meridian circles, zenith sectors, or other suitable instruments of high precision are employed, so that finally both linear and angular measurements of the same arcs become available for the calculation of the earth's dimensions.

The oldest triangulation of which history tells us was made by Snellius, in Holland, before 1617; but work of precision may be said to have begun when Picard, in 1666, replaced the sights previously employed with surveying instruments by a telescope fitted with cross wires. This new feature not only introduced greater accuracy, but greatly enlarged the possible extent of the triangles. Picard himself measured a small arc, and deduced the first value of the earth's radius which approached precision. Prior to this, the English mile, which professed to state the length of a minute of arc, was one-sixth too great, and

* "Arc du Méridien de 25° 20′ entre le Danube et la Mer Glaciale." Par F. G. W. Struve. (St. Pétersbourg, 1862.)

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we shall never know how many shipwrecks may have been due to this error. Even more important, from the scientific point of view, was the fact that Picard's new

Triangulation near the River Danube.

measurement furnished Newton with the long-desired confirmation of the law of gravitation.

The idea of a Russian meridian arc had its birth in the first half of the last century, when the Paris Academy of Sciences was so hotly discussing the figure of the earth as derived from the discordant results of different geometers. Delisle, indeed, actually commenced operations in 1737, but, for reasons not sufficiently known, his project was abandoned.

In 1812, while still a student at the University of Dorpat, Struve was struck by the great advantages which the region between the Danube and the Arctic Ocean offered for a trigonometrical survey. A stretch of country almost free from high mountains, the astronomical observations would be correspondingly little disturbed by local attractions. In the summer of 1812, Struve, single-handed, made a small survey, measuring a base line, and carrying on a triangulation with a Troughton sextant. His work, however, was interrupted by war, but it sufficed to show the feasibility of a greater undertaking. After his appointment to the observatory of Dorpat, Struve's projects received official recognition, and the Emperor Alexander I. granted the funds necessary to complete the measurement of an arc of 3° 35′. This was concluded in 1828, and was subsequently joined to an arc which had been almost simultaneously measured by General Tenner. The junction between the two surveys was made in 1831, the total arc then amounting to 8° 2·5′, between Hogland and Bélin. A lacuna of 5° 26′ between this Russian arc and the Lapland arc previously measured by the French and Swedes was next attacked, the Emperor Nicholas I. cordially supporting the work by an annual grant of three thousand roubles for ten years. It was not until 1844, however, that this portion of the great arc, terminating at Tornea, latitude 65° 50′, was completed. During the next seven years the arc was extended to Staro-Nekrassowka, on the Danube, in a southerly direction, by General Tenner, and to Fuglenaes, Hammerfest, towards the north, by the Norwegians and Swedes.

With due respect for the historic rights of the Academy of Stockholm, M. Struve was deputed to impress on that body the importance of extending the Russian arc to the northern extremity of the continent, and a personal interview with the King, Oscar I., led to the desired object. Reconnoitring expeditions were first sent out, stations were selected, and Hammerfest, for various practical reasons, was determined upon as the extreme end of the arc. Surveying in these high latitudes is beset with many difficulties. Owing to the mountainous character of the country, transport is difficult, while inhabitants are few and wood is scarce. Hammerfest, for instance, is pardonably proud of a scraggy clump of dwarf birch, a score or two in number, for this is the nearest approach to a wood within many miles radius.

Near the southern limit of the arc, excessive vegetation, in the shape of almost impenetrable forests, presented great obstacles, and observing platforms and signals nearly one hundred and fifty feet in height had sometimes to be erected.

Finally, after nearly forty years' labours, the measurement of the great arc was accomplished. Altogether ten bases were measured and two hundred and fifty-eight principal triangles were involved. From end to end the meridian arc traverses no less than two thousand eight hundred and eighty kilomètres, embracing about one-fourteenth of the earth's circumference.

The southern termination, at Staro-Nekrassowka, latitude 45° 20′ 2·8″, is marked by a truncated pyramid of cast iron, resting on a cube of seven feet side, bearing an inscription almost identical with that of the Hammerfest monument.

Combining the results of the Russian arc of meridian with the Anglo-French, Indian, Cape, and Peruvian arcs, and an Indian arc of longitude (giving a total amplitude of 89° 32′), and regarding the shape as spheroidal, General Clarke determined the following values for the size of the earth:—

Equatorial diameter = 41,852,404 feet.
Polar diameter = 41,709,790 feet.

While there is reason to believe that an equatorial section of the earth should be regarded as an ellipse—in other words, that the earth is an ellipsoid—it is not yet considered by the best authorities that the available data are sufficient for fixing definitively the form and dimensions of the imaginary geometrical smooth body which most nearly approximates to the actual contour of the earth's surface.

As Struve pointed out at the conclusion of his labours, nature presents no obstacle to the southern extension of the great arc by another 12°; and, more recently, Dr. Gill has looked forward to its connection with the South African survey which has just been completed. Dr. Gill considers that the South African triangulation might be extended to the mouth of the Nile, and then, by an additional network of triangles along the coast of the Levant and through Greece, the junction with Struve's meridian could be made so as to produce a stupendous arc of 105°. Many years must elapse before such an enormous undertaking can be completed, but its importance as a contribution to exact geodesy cannot be over-estimated.

THE FACE OF THE SKY FOR JUNE.

By HERBERT SADLER, F.R.A.S.

MERCURY is too near the Sun during the first third of the month for convenient observation by the amateur. On the **16th** he rises at 2h. 50m. A.M., with a northern declination of 17° 21′, and an apparent diameter of 8″. He is at his greatest western elongation at 6h. A.M. that morning. On the **22nd** he rises at 2h. 43m. A.M., with a northern declination of 19° 26′, and an apparent diameter of 7″. On the **30th** he rises at the same time, or about one hour before the Sun, with a northern declination of 22° 17′, and an apparent diameter of 6″. While thus imperfectly visible he describes a direct path in Taurus to the borders of Gemini.

Venus is a morning star, and is well placed for observation in June. She is at her greatest brilliancy on the **3rd**. On the **1st** she rises at 2h. 25m. A.M., with a northern declination of 11° 2′, and an apparent diameter of 39½″. On the **10th** she rises at 2h. 5m. A.M., with a northern declination of 11° 44′, and an apparent diameter of 34¼″, about one-third of the disc being illuminated. On the **20th** she rises at 1h. 46m. A.M., or just two hours before the Sun, with a northern declination of 13° 20′, and an apparent diameter of 29½″. On the **30th** she rises at 1h. 30m. A.M., or 2h. 15m. before the Sun, with a northern declination of 15° 23′, and an apparent diameter of 26″. During June she describes a direct path through the greater part of Aries into Taurus, without approaching any conspicuous star very closely.

Mars has practically left us for the year, the tiny disc he now presents exhibiting no features of interest for the purposes of the amateur observer.

Jupiter can still be observed as an evening star, but should be looked for as soon after sunset as possible. On the **1st** he sets at 0h. 45m. A.M., with a northern declination of 11° 48′, and an apparent equatorial diameter of 36½″, the phasis on the *f* limb amounting to $\frac{3}{10}$″. On the **10th** he sets at 0h. 10m. A.M., with a northern declination of 11° 25′, and an apparent equatorial diameter of 35½″. On the **20th** he sets at 11h. 30m. P.M., with a northern declination of 10° 55′, and an apparent equatorial diameter of 34¾″. On the **30th** he sets at 10h. 53m. P.M., with a northern declination of 10° 21′, and an apparent equatorial diameter of 34″, the phasis on the *f* limb amounting to $\frac{2}{10}$″. During June he describes a short direct path in Leo, to the east of Regulus, being just about 1° north of the fourth magnitude star ρ Leonis on the evening of the **21st**.

Saturn is an evening star, and but for his great southern declination would be well placed for observation. He rises on the **1st** at 6h. 20m. P.M., with a southern declination of 17° 10′, and an apparent equatorial diameter of 18″ (the major axis of the ring system being 42¾″ in diameter, and the minor 17¼″). On the **10th** he rises at 5h. 36m. P.M., with a southern declination of 17° 3′, and an apparent diameter of 18″. On the **20th** he rises at 5h. 3m. P.M., with a southern declination of 16° 54′, and an apparent diameter of 17¾″. On the **30th** he rises at 4h. 20m. P.M., with a southern declination of 16° 51′, and an apparent equatorial diameter of 17½″. During June he describes a retrograde path in Libra.

Uranus is an evening star, but is very badly placed for observation. On the **1st** he rises at 6h. 32m. P.M., and souths at 10h. 54m. P.M., with a southern declination of 19° 9′, and an apparent diameter of 3·7″. On the **30th** he rises at 4h. 33m. P.M., and souths at 8h. 56m. P.M., with a southern declination of 18° 55′. During the month he describes a short retrograde path in Libra, being about 2° south of Saturn at the end of the month.

Neptune is in conjunction with the Sun on the **10th**.

There are no well-marked showers of shooting stars in June.

The Moon enters her first quarter at 7h. 2m. A.M. on the **8th**; is full at 9h. 1m. P.M. on the **14th**; enters her last quarter at 11h. 24m. P.M. on the **21st**; and is new at 2h. 55m. A.M. on the **30th**.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of May Problems.

(W. J. Ashdown.)

No. 1.

1. Q to Kt7, and mates next move.

No. 2.

1. P to K6, and mates next move.

[These problems, and especially No. 2, have evidently proved very puzzling. Many have sent 1. K to K6 as the key to No. 2, overlooking the available defence in 1. . . . Q×BP. 1. R to K3 is also a tempting try, met only by 1. . . . Q to B5. There are duals in both problems.]

CORRECT SOLUTIONS of both problems received from W. Clugston, H. H. Thomas, J. T. Blakemore, J. H. Ballantine, J. M'Robert, Kappa, A. E. Whitehouse.

Of No. 1 only from W. H. Lunn, W. H. Brenchley, E. W. Brook, Alpha, A Norseman, Rev. F. W. Quilter, D.D.

Of No. 2 only from G. G. Beazley.

W. W. Stead and *A Norseman.*—If 1. R to K8, Q to B5.

Sigma.—1. Q to KB4 is met by 1. . . . K to Q5.

G. G. Beazley.—If 1. P to B4, Black has many defences.

H. le Jeune.—See reply to "Sigma." Your solutions last month were too late to acknowledge.

J. H. Ballantine.—Thanks for the problem, which shall be examined.

E. W. Brook.—It is a novelty to find you caught tripping.

W. B. Hawkins.—After taking the Knight, the Black Knight can interpose at K2 in answer to the Queening of the Pawn.

W. Clugston.—Problem received with thanks. Your turn comes next month. A first-class block problem with one dual would probably lose about fifteen per cent. of its marks in a tourney. In the case of a threat problem, or where the dual is clearly unavoidable (*i.e.*, without upsetting the entire scheme of the problem), the deduction would be rather less. There is also a reduction of penalty in the case of *repeated* duals. For instance, in No. 2 (May Number) the duals after QKt7 and QR8 would not count as much more than one.

Sentimental Tommie.—Yes, once in May. Your contributions are always welcome; and even the "inferior" one has some good points.

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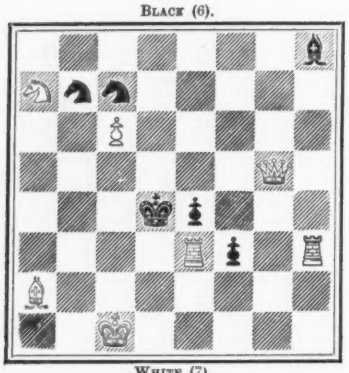
PROBLEMS.

By T. Raddick.

No. 1.

BLACK (6).

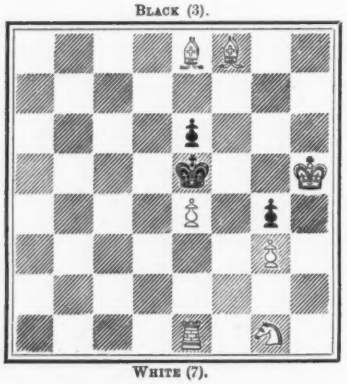


WHITE (7).

White mates in two moves.

No. 2.

BLACK (3).



WHITE (7).

CHESS INTELLIGENCE.

The Pillsbury-Showalter match, for the championship of America, resulted, after a protracted struggle, in a victory for Mr. Pillsbury. The final score was:—Pillsbury, 10; Showalter, 8; drawn, 4—a result which will greatly increase the loser's reputation.

Mr. T. H. Cole is playing a match with Mr. Teichmann, who won the first game.

A cable match between the House of Commons and the American House of Representatives will be decided as we go to press.

An international tournament is being arranged to take place in Berlin, probably in August. It is hoped that the German Emperor will be a prize-donor.

Mr. D. Y. Mills has, as usual, won the Scottish championship, and now holds the challenge cup permanently.

Thirty-two entries have been received for the ladies' international tourney which begins on June 23rd at the Hotel Cecil. The strongest of these will be selected by the committee. The prizes are on a scale hitherto unknown to the male amateur, amounting as they do to more than £200. It is hoped that Mrs. Showalter will compete.

We have great regret in announcing the death of Dr. C. Schmid, of Dresden, certainly one of the most brilliant players in Germany, and the winner of the second prize in the Leipzig Tourney of 1877. His analytical contributions to the *Chess Monthly* and the *Schachzeitung* are well known.

Appended is a brief game played on May 15th in the match between Hastings and the City of London. It illustrates one of the many possibilities of an early attack in the *open* "Ruy Lopez."

"Ruy Lopez."

WHITE. (C. D. Locock.)	BLACK. (H. W. Trenchard).
1. P to K4	1. P to K4
2. KKt to B3	2. QKt to B3
3. B to Kt5	3. P to QR3
4. B to R4	4. Kt to B3
5. P to Q4	5. P×P
6. Castles	6. B to K2
7. P to K5	7. Kt to K5
8. Kt×P	8. Castles
9. P to QB3 (*a*)	9. Kt to B4
10. B to B2	10. Kt×KP ?
11. Q to R5 (*b*)	11. Kt to Kt3 (*c*)
12. P to KB4	12. R to Ksq (*d*)
13. P to B5	13. Kt to Bsq
14. P to QKt4 (*e*)	14. P to Q3
15. P×Kt	15. P×P
16. B to Kt3 (*f*)	16. Resigns.

NOTES.

(*a*) Much better than 9. Kt to B5, as recommended by all the books. Black's reply is perhaps inferior to 9. . . . P to B3, but his next move is the mistake.

(*b*) 11. B×Pch would give Black the superior game.

(*c*) If 11 . . . Kt(K4)Q6, 12. P to QKt4, P to KKt3; 13. Q to Qsq (!) winning a piece.

(*d*) To provide a square for the Knight; but he does not realize the other dangers of his position. In any case the game is difficult to defend now.

(*e*) Which Black evidently had overlooked.

(*f*) Another decisive change of the point of attack. There is no reply.

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